[2026]

The Status of Biological Invasions and their Management in South Africa

[DRAFT FOR PUBLIC COMMENT]

Note to reader

We are inviting you to submit comments, corrections, and queries on this fourth status report on biological invasions[1]. We have prepared a standard form for commenting that you can fill in if you wish, but if you would prefer to send in your inputs in your own format, please indicate the page and line numbers to which your comment refers. Many of the technical details (and data on which the report is based like the list of alien species) are available in the appendices and supplementary material (links available on the last page). Please also consider commenting on these. If you are in a position to provide additional information, we would be very grateful. We will aim to ensure all contributors are appropriately acknowledged. If you do not wish to be named, please let us know. We would like as many people and organisations to make inputs as possible, so please send on. We will capture all comments received during this commenting period and track how they are responded to. A database of these comments and the responses will be available on request once the report has been released.

Comments to be sent to: IAS.report.SANBI@gmail.com By: 1 March 2026

Form for comments: https://tinyurl.com/h7fxmu6u

We are also very keen to find how we can make the report more useful for you and your organisation. As such we would also be very grateful is you completed a questionnaire (should take 10 to 15 minutes) available at: https://tinyurl.com/ycymbd3v also by 1 March 2026

This is a draft report[2]. The report is based on information up to the end of December 2025, while much of this has been included there are still some analyses to be completed. Therefore, the results are demonstrative of what the final report will look like rather than necessarily indicative of the current state as it will be presented in the final report. Specific sections where work is on-going are flagged either with a note in square brackets or in a footnote to the text.

Thank you in advance for your comments, we appreciate you taking the time to engage with us.

Yours sincerely,

Dr Tsungai Zengeya

(on behalf of the fourth status report drafting team)

Kirstenbosch, 30 January 2026

[1]The previous status reports are available to download at http://iasreport.sanbi.org.za/; and https://dx.doi.org/10.5281/zenodo.7414803, links for on-line resources are available at end of this report. For a statement on the independence of this report see S0.1

[2]For a statement on editorial conventions see S0.2

Citing this publication

For citations in the scientific literature: Zengeya TA, Faulkner KT, van Wilgen BW, Wilson JR (Eds) (2026) The status of biological invasions and their management in South Africa in 2025 [DRAFT FOR PUBLIC COMMENT]. South African National Biodiversity Institute (Kirstenbosch) and Centre for Invasion Biology (Stellenbosch): 156. http://dx.doi.org/10.5281/zenodo.17697657

For citations in policy documents: SANBI and CIB (2026) The status of biological invasions and their management in South Africa in 2025 [DRAFT FOR PUBLIC COMMENT]. South African National Biodiversity Institute (Kirstenbosch) and Centre for Invasion Biology (Stellenbosch): 156. http://dx.doi.org/10.5281/zenodo.17697657

Example of a citation to an individual chapter: Faulkner KT (2026) Chapter 1: Pathways. In: Zengeya TA, Faulkner KT, van Wilgen BW, Wilson JR (Eds) The status of biological invasions and their management in South Africa in 2025 [DRAFT FOR PUBLIC COMMENT]. South African National Biodiversity Institute (Kirstenbosch) and Centre for Invasion Biology (Stellenbosch): 43–55. http://dx.doi.org/10.5281/zenodo.17697657

ISBN: to be included in the final report

Authors

Lead editors: Tsungai A. Zengeya, Katelyn T. Faulkner, Brian W. van Wilgen, John R. Wilson

Additional Chapter Lead Authors: Masingitla P. Mtileni

With contributions from: Pia Addison, Johan Baard, Felipe Balocchi, Richard Burns, Sonja Coerze, Sarah Davies, Michelle De Bruyn, Carlo De Kock, Paul Fourie, Llewellyn Foxcroft, Martin Hill, Marcini Govender, Zanele Jele, Minette Karsten, Mahube Makuse, Carina Malherbe, Grant Martin, Tumeka Mbobo, Emily McCulloch-Jones, Marco Meyer, Themba Mnguni, Debbie Muir, Wilma Nel, Welri Nortje, Bheka Nxele, Iain Paterson, Mashudu Phalanndwa, Iva Přikrylová, Alana Rebelo, Heiner Riffel, Tammy Robinson, Davina Saccaggi, Zikhona Sokudela, Louise Stafford, Mfundo Tafeni, Nicola van Wilgen, Karabo Wanjau, Andrew Wannenburgh, Costas Zachariades, Bongani Zungu

[Note: The authorship list is expected to expand in the next draft]

Table of Contents

Foreword by DFFE Minister

Preface by SANBI Board Chair

Preface by SANBI CEO

[Note: the foreword and prefaces are to cover the purpose and context of the report, the scope, legal requirement, principal findings and their implications, and any personal reflections. Each to be ~2 printed pages including a photograph. These will only be added immediately prior to publication]

List of acronyms[3]

ASRARP	Alien Species Risk Analysis Review Panel
A&IS	Alien and Invasive Species as referred to either in the NEM:BA A&IS Regulations or the NEM:BA A&IS Lists published under the regulations
CBD	the Convention on Biological Diversity of the United Nations
CIB	the Centre for Invasion Biology, until 2024 a Department of Science and Innovation-National Research Foundation Centre of Excellence, since then part of Stellenbosch University's School for Climate Studies
DFFE	the Department of Forestry, Fisheries, and the Environment
DoA	the Department of Agriculture
EICAT	the International Union for Conservation of Nature (IUCN)'s Environmental Impact Classification for Alien Taxa
GBF	the Kunming-Montreal Global Biodiversity Framework of the CBD
NEM:BA	the National Environmental Management: Biodiversity Act (Act No. 10 of 2004)
NEM:BA A&IS: see **A&IS**	
QDGC	quarter-degree grid cell
RAC	the Reference and Advisory Committee (of this fourth status report)
SANBI	the South African National Biodiversity Institute
SAPIA	the Southern African Plant Invaders Atlas
SEICAT	Socio-Economic Impact Classification for Alien Taxa
WfW	the Working for Water programme
ZAR	South African Rands

[3] These acronyms are based on those used in the third report, they will be cross-checked and updated as needed for the second order draft

Glossary[4]

abundance (cf. **distribution**, **extent**): a measure of the number of individuals, coverage, or biomass of an organism in a specified **site**.

adaptive management: a structured, iterative process that includes the setting of goals, regular monitoring of progress towards the achievement of those goals, and, based on the findings of the monitoring, the adaptation of management to improve its effectiveness or a revision of the goals. Adaptive management is useful where the outputs and outcomes of management are uncertain, and where an approach of learning-by-doing can reduce uncertainty over time.

alien species (cf. **extralimital**, **native species**): a species that is present in a **site** outside its natural range as a result of human action that has enabled it to overcome biogeographic barriers.

assessment: a critical evaluation of information.

ballast water: *"…water that is pumped into tanks to stabilise cargo ships…Water can be taken on in large quantities in one harbour and then discharged in the next…When the water is taken on board or when it is discharged there are species and their propagules (including pathogens and algae), that may be spread around the world."* (Harrower et al. 2018)

biodiversity: the variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

biological invasions: the phenomenon of, and suite of processes that are involved in determining, the transport of organisms to **sites** outside their native range by human activities and the fate of the organisms in their new ranges. **Biological invasions** affect all regions and **biomes** of the world, including marine, terrestrial, and freshwater environments.

biological control (syn. **biocontrol**): the use of specimens of one species for the purpose of preying on, parasitizing on, damaging, killing, suppressing or controlling a specimen of another species.

biocontrol: see **biological control**.

biofouling: the phenomenon of organisms attaching themselves to submerged surfaces and that can lead to spread within and between regions. If the submerged surface is specifically the hull of a boat or ship the term 'hull fouling' is used (adapted from Harrower et al. 2018).

biome: a large naturally occurring community of plants and animals that have common characteristics in similar physical environments, e.g., desert or forest.

biosecurity: measures that are taken to stop the **introduction** or **dispersal** of organisms harmful to human, animal, or plant life.

compliance: The action or fact of complying with instructions, in this report such instructions primarily refer to the provisions of NEM:BA.

---

[4]These definitions are based on those in the third report with consideration of definitions given in relevant South African and international legislation and reports, specifically the NEM:BA and its A&IS Regulations, the CBD (https://www.cbd.int/invasive/terms.shtml), and the IPBES IAS Assessment (https://www.ipbes.net/glossary-definitions?search_api_fulltext=&field_deliverable=Invasive+alien+species+assessment). These cover terms used in this fourth report and in the supplementary material to the fourth report. Note: this version has not been cross-checked, this will be done for the final draft.

contaminant: the accidental **introduction** of an **alien species** with an intentionally transported commodity with which the organism has a specific, natural association.

control: any action taken to prevent the recurrence, re-establishment, re-growth, multiplication, propagation, regeneration or spreading of an **alien species**.

corridor: the natural spread of an **alien species** into a new region through a human-constructed transport infrastructure that connects previously unconnected regions, and in the absence of which **dispersal** would not have been possible.

dispersal (syn. **spread**): movement of organisms that is facilitated either intentionally or accidentally by humans, or that occurs naturally.

distribution: the **extent** and **abundance** of a species over a given **site**.

eradication: the complete removal of all individuals and propagules of a population of an **alien species** from a particular **site** to which there is a negligible likelihood of reinvasion (for the purposes of this report the **site** is either continental South Africa or the Prince Edward Islands). If there is a likelihood of reinvasion or that possibility was not explicitly assessed the term extirpation would be preferred, in such cases other populations might be close by or pathways of introduction and dispersal are still operating such that the probability of re-invasion is probable or not known.

escape (cf. **release**): the **spread** of an **alien species** that was intentionally **introduced** and kept in captivity or cultivation to sites outside of captivity or cultivation. Includes both natural spread and the accidental or intentional illegal human-mediated **dispersal** of live organisms from the site of captivity or cultivation.

established (syn. **naturalised**.): **alien species** that sustain self-replacing populations for several life cycles or over a given period of time without direct intervention by people, or despite human intervention.

extent (cf. **abundance**, **distribution**): the broad-scale area over which an organism occurs. The spatial scale over which extent is measured needs to be specified. The occupancy of sites at a fine-spatial scale is often equivalent to the **abundance**.

extralimital: see **native-alien populations**

impact: the effect of an **alien species** on the physical, chemical, and biological environment. It can include both negative and positive effects.

incursion: an isolated population of a pest, weed, or **alien species**, that usually has a limited spatial extent and has been recently detected at a **site**. In general, the **management** of incursions is referred to as incursion response.

indicator: a set of measurements that give specific information about the state of something.

interventions: the full variety of actions taken in response to biological invasions, including direct actions, i.e., **control,** and indirect actions like **monitoring**, **regulation**, and research.

introduced: see **Introduction**.

introduction: the movement of an **alien species** (either accidentally, intentionally and legally, or intentionally and illegally) by human activity, to a region outside its native range. Introductions can also refer to species which were introduced to one country by humans and spread naturally to neighbouring countries. In the context of introductions, the term ‘accidental’ is preferred to the synonymous term ‘unintentional’.

introduction pathway prominence: an indicator used to assess the status of **introduction pathways**. The indicator assesses the introduction opportunities that are available for alien organisms to be introduced to a country from other regions. The indicator considers introduction opportunities in terms of how socioeconomically active the pathways are (e.g., amount of ballast water released), rather than how many organisms are introduced through a pathway.

invasion: see **biological invasions**.

invasive alien species: see **invasive species**.

invasive species: **alien species** that sustain self-replacing populations over several life cycles, produce reproductive offspring, often in very large numbers at considerable distances from the parent and/or site of introduction, and have the potential to **spread** over long distances. **Invasive species** can be plants, animals, fungi, and micro-organisms and are found across the world throughout freshwater, marine, and terrestrial environments.

monitoring: a systematic process of collecting and analysing information to track progress towards reaching stated goals, that facilitates the assessment of the efficacy of **interventions**.

native-alien populations (syn. **extralimital**; cf. **alien species**, **native species**): a population of a taxon that is native to a part of South Africa, but that was founded by individuals moved by direct human agency, over a biogeographical barrier, to an area beyond the species' native range (i.e., it can be considered a biological invasions) (see Box 2.1). This does not include **native species** that have extended their distribution by **natural dispersal**.

native species (syn. indigenous species, cf. **alien species**, **native-alien population**): species that are found within their natural range where they have evolved without human intervention (intentional or accidental). Also includes species that have expanded their range as a result of human modification of the environment that does not directly impact dispersal (e.g., populations are still considered native if they result from an increase in range as a result of watered gardens, but are considered alien if they result from an increase in range as a result of spread along human-created corridors linking previously separate biogeographic regions).

naturalised: see **established**, the term naturalised has been deprecated.

natural dispersal (syn. **unaided**): the **dispersal** of an **alien species** through natural spread from a region where it was previously introduced through human assistance or action, to another region where it is not native. Includes both self-propelled movement and movement with natural biotic (e.g., birds) and abiotic vectors (e.g., wind or water).

pathway (cf. **vector**): a broadly defined term that refers to the combination of processes and opportunities that result in the movement of **alien species** from one place to another. Includes the cause or reason why the organism is transported, the route along which it is transported, and the **vector** that carries the organism.

permit: an official document issued in terms of Chapter 7 of National Environmental Management: Biodiversity Act, 2004 (Act no. 10 of 2004).

pest: an organism that causes negative impacts. The affected sector might be specified, so an agricultural pest will **impact** negatively on agricultural production. Pests can be **alien** or **native species**, and are usually taken to refer to animals, with pest plants often rather referred to as weeds and pest fungi or microbes referred to as diseases.

policy: a high-level overall plan, adopted by the Executive Authority, for achieving identified outcomes through specified methods or principles that guide decision-making. A **policy** on **biological invasions** would be a high-level plan which identifies goals concerning **biological invasions** in South Africa and identifies the **interventions** that should be used to achieve those goals.

regulation: 1) a law or rule made by the Executive Authority in terms of original legislation to regulate conduct (in this case the **NEM:BA A&IS Regulations**); 2) the act of regulating, i.e., to govern or direct according to rule, or to make regulations (authoritative rules) for certain conduct.

release (cf. **escape**): the intentional **introduction** of an **alien species** to a site outside of captivity or cultivation. This refers to both legal and illegal introductions, however if a legally introduced **alien species** is illegally released outside of captivity or cultivation then it is classified as an **escape**.

returns on investment: the amount of value that is gained as a result of a particular amount spent on an intervention. This can be calculated as a benefit: cost ratio whereby each rand spent (the cost) is set against the amount of rands gained (benefit). An intervention is technically cost-effective if the benefit: cost ratio is greater than one, although more generally cost effectiveness is about maximising the ratio.

risk: the likelihood and consequence of an event, in this report the event is a **biological invasion**

risk analysis: the process of identifying and assessing the likelihood and consequence of an event, as well as considerations as to how to manage and communicate the **risk**.

risk assessment: a component of **risk analysis** that focuses on evaluating the likelihood and consequence of an event taking place. In the context of this report, such an event is the likelihood of an **alien species** becoming an **invasive species** and the negative **impacts** that would result. Note in the 2020 **NEM:BA A&IS Regulations** the term **risk assessment** is used as a synonym for **risk analysis**, i.e., risk management considerations are included.

site: a defined spatial area, for example a protected area (as defined by the National Environmental Management: Protected Areas Act, 2003); or an administrative unit (with national and provincial administrative boundaries as defined by the Constitution of the Republic of South Africa, 1996).

spread: see **dispersal**

status: the state, condition or stage of affairs at a particular time.

strategy: a high-level plan for achieving management goals in a specific time frame under conditions of uncertainty.

stowaway: the accidental **introduction** of an **alien species** attached to or within a transport vector or their associated equipment and media. The organism is transported by chance, and there is no specific, natural association with the vector.

taxon (pl. **taxa**): a group of organisms that all share particular properties (usually evolutionary history). The grouping can be below, at, or above the species level.

threat: the negative impacts that may occur if an event happens (cf. **risk** where the likelihood is explicit). In this context this refers to the negative **impacts** resulting from a component of the **invasion debt** being realised.

unaided: see **natural dispersal**.

unregulated introduction: an **introduction** that was not approved by the relevant South African authorities under the relevant regulations prior to the date at which it arrived in the country.

vector (cf. **pathway**): the physical means or agent that transports the alien species. Can be both human mediated (e.g., ballast water, clothing, animal feed, or land vehicles) or natural (e.g., wind, water, birds).

Water Management Area: an area established as a management unit in the national water resource strategy within which a catchment management agency conducts the protection, use, development, conservation, management, and control of water resources.

Summary of key messages[5]

Biological invasions are a major threat to South Africa's water security, exacerbate fires, threaten sustainable agriculture, and are having ongoing major negative impacts on South Africa's unique and globally important biodiversity. This phenomenon is not unique to South Africa nor to any one part of the country, and thus addressing biological invasions requires integrated governance from international to local levels. Of immediate concern, however, is that the number of alien species is increasing, the area invaded is growing, but South Africa's response has been declining.

These issues are addressed in detail in the report 'The Status of Biological Invasions and their Management in South Africa'. The key messages from this report are summarised here in the form of a single headline followed by explanatory text with cross-references (in curly brackets) to the relevant sections of the report. Each statement is also ascribed one of four confidence levels (*inconclusive*, *unresolved*, *established but incomplete* and *well established*) as per the guidelines of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2018).

The messages are grouped around five themes with corresponding indicators for each theme: A) how alien species are introduced and move around the country ('pathways'); B) the status and impacts of alien species ('species'); C) how sites are invaded and impacted ('sites'); D) what has been done to address the problem ('interventions'); and E) the monitoring framework. These messages are specifically intended to help gauge progress with management and advise those tasked with developing policy responses, though the messages should also provide useful general insights to all those interested and affected by biological invasions.

[5]This summary of key-messages is produced as part of fulfilling SANBI's mandate under the NEM:BA (Act 10 of 2004) and its A&IS Regulations of 2020 to submit a report on the status of invasive species and the effectiveness of measures to combat them to the Minister of Forestry, Fisheries and the Environment every three years. This is the fourth such report and presents an update on issues identified in the previous reports. For citations to this summary please cite the full report: SANBI and CIB. 2026. The status of biological invasions and their management in South Africa in 2025 [DRAFT FOR PUBLIC COMMENT]. South African National Biodiversity Institute, Kirstenbosch and Centre for Invasion Biology, Stellenbosch. http://dx.doi.org/10.5281/zenodo.17697657

Table of key messages

A1: There are a wide range of opportunities for introductions, and new alien species continue to arrive every year through several pathways

A2: Alien species are spreading around South Africa, with this spread being facilitated by humans and occurring naturally

B1: The process of collating a list of alien species in the country has been substantially improved and documented, this will promote transparency, and facilitate management and regulatory decisions

B2: The adoption of standard practises to integrate biodiversity data means data on species occurrences can be used as the basis for models and indicators to monitor biodiversity status and change

B3: Knowledge of the distribution and abundance of alien plant species has improved; but structured surveillance remains essential to inform management and track trends

B4: Invasive species, in particular trees and freshwater fishes, have 'Major' negative impacts on people and nature across the country

C1: Invasions are distributed across the country including in protected areas

C2: Country-wide assessments indicate that invasive plant species are widespread, with several biomes and strategic water catchment areas experiencing substantial and increasing levels of invasion despite ongoing control efforts, except for taxa subjected to biological control

C3: The impact of invasions on water resources, rangeland productivity, and biodiversity are severe; workflows to track these impacts are vital for prioritising interventions but are currently not in place

D1: Funding for the management of biological invasions has declined steeply

D2: South Africa has an innovative regulatory system to address biological invasions, but its implementation is limited

D3: Intentional legal introductions are well regulated. The National Border Management Authority (BMA) became operational in 2023; but inspections for environmental threats have declined and illegal and accidental introductions continue

D4: The ongoing absence of monitoring systems limits South Africa's ability to improve the management of biological invasions

D5: Biological invasions have been effectively managed in a few cases, with biological control proving particularly successful

E1: South Africa has a sophisticated range of processes to address biological invasions but the monitoring of these is currently insufficient to evaluate their effectiveness

E2: Integrated governance will be crucial to improve the effectiveness of interventions

A) How alien species are introduced and move around the country

Head-line indicator	Trend[6]	Confidence	Notes
1. *Rate of introduction of new unregulated species*	→	low	Over the last decade (2016–2025) approximately four new taxa were introduced per year either accidentally or intentionally but illegally. This is similar to previous estimates

Indicator	Trend	Confidence
1.1. *Introduction pathway prominence*	→	medium
1.2. *Introduction rates*	→	low
1.3. *Within-country pathway prominence*	not assessed	NA
1.4. *Within-country dispersal rates*	not assessed	NA

A1: There are a wide range of opportunities for introductions, and new alien species continue to arrive every year through several pathways

New alien species continue to arrive every year in South Africa (*well established*) {1.1, 1.2}, with the rate of their introduction remaining stable at around four per year (*established but incomplete*) {1.1, 1.2}. Besides biological control agents, the new species detected since December 2022 have been accidentally introduced through several pathways (e.g., with imported plants and their products, and through shipping) (*established but incomplete*) {1.2}. Pathways related to intentional introductions are better regulated than in the past, but still pose a threat (*established but incomplete*) {4.1, 4.7}. For example, records from social media show a range of alien pet birds are escaping from captivity; and several studies have highlighted the size and diversity of the aquarium trade, and the various types of introductions that it can facilitate (*established but incomplete*) {1.1, 1.2}. While biocontrol agents have often significantly reduced the negative impacts of invasions (*well established*) {4.8}, other new alien species are adding to the range, complexity and intensity of the negative impacts caused (*established but incomplete*) {2}. The opportunities for invasive species to arrive are expected to increase as the volume of trade and travel increases; appropriate biosecurity can ensure such trade is sustainable.

[6] → no change; ↗ an increase; ↘ a decrease

A2: Alien species are spreading around South Africa, with this spread being facilitated by humans and occurring naturally

Many pathways are providing opportunities for the within-country dispersal of alien species, and while the extent of this role and how it has changed recently is not known, it is clear that alien species are being moved around the country in a myriad of ways (*well established*) {1.3, 1.4}. For example, South Africa plays a large role in the international pet trade, breeding animals (particularly alien birds) for export and local use; and alien plants are moved around the country through formal and informal trade, and by animals such as baboons and birds (*established but incomplete*) {1.3, 1.4}. Consequently, alien species continue to spread and native species are being introduced to places outside of their native ranges, causing negative impacts, and putting valuable assets at risk (*well established*) {2}. Preventing both native-alien populations and the further spread of existing alien species will require a greater focus on tracking and managing species movements within the country.

B) The status and impacts of alien species

Head-line indicator	Trend[7]	Confidence	Notes
2. *Number of invasive species that have 'Major' impacts*	↗	low (many taxa still need to be assessed)	National assessments using IUCN's Environmental Impact Classification for Alien Taxa framework show significant impacts, with 19 species having been assessed as causing 'Major' or 'Massive' impacts. Complementary assessments using risk analyses and findings from the IPBES IAS Assessment confirm that these species cause widespread harm across multiple sectors of society. However, as only few taxa have been formally assessed, the need for more studies and assessments on the impact of invasive species has been highlighted as a research priority for South Africa.

Indicator	Trend	Confidence
2.1. *Number and status of alien species*	↗	high
2.2. *Extent of alien species*	↗	medium
2.3. *Abundance of alien species*	↗	medium
2.4. *Impact of alien species*	↗	low

B1: The process of collating a list of alien species in the country has been substantially improved and documented, this will promote transparency, and facilitate management and regulatory decisions

There has been significant progress in collating a list of alien species in the country, the process and list of alien species, with information, where available, on their distributions, impacts and management has been documented (*established but incomplete*) {2, 4.1, 4.5, 4.8}. The development of documented and repeatable workflows ensures it is clear why species are included on the list and facilitates updates to the lists (*established but incomplete*) {Appendix 4}. To date the list includes records of over 3 800 alien species present in South Africa, at least a third of which are recorded as invasive (*established but incomplete*) {2.1}. As data are captured and collated these numbers will increase: key sources still need to be verified and integrated into the list (particularly species in cultivation); and many alien species are yet to be detected and documented. A comprehensive list will facilitate tracking the *number and status of alien species* over time, feeding into management planning and facilitating regulatory decisions.

[7] → no change; ↗ an increase; ↘ a decrease

B2: The adoption of standard practises to integrate biodiversity data means data on species occurrences can be used as the basis for models and indicators to monitor biodiversity status and change

Biodiversity monitoring requires access to rapid, reliable, and repeatable monitoring data that can be used to inform policy, decision-making, and interventions. The process of mobilising and analysing spatial data has been improved by adopting practices from other global initiatives that have developed pipelines to integrate biodiversity data into data cubes that can be used for models and indicators of biodiversity monitoring (*established but incomplete*) {2.2, 3.1}. These data cubes and workflows have assisted with the automation and standardisation of the process and how the status reports are communicated.

B3: Knowledge of the distribution and abundance of alien plant species has improved; but structured surveillance remains essential to inform management and track trends

There is limited data to estimate the extent and abundance of alien species in South Africa (*established but incomplete*) {2.2, 2.3}. Several atlasing and remote sensing projects have provided estimates of the abundance of selected invasive plant taxa in water catchments and terrestrial biomes {2.3}. Data from the surveys indicate that most of the taxa have increased in cover despite mechanical and chemical control efforts, but there were decreases in cover for taxa under biological control (*established but incomplete*). There is however no national long-term structured monitoring project to track plant invasions across South Africa. Ensuring the long-term sustainability of structured surveillance efforts and integrating these with other monitoring projects (e.g., citizen science observations), will support management planning and facilitate regulatory decisions.

B4: Invasive species, in particular trees and freshwater fishes, have 'Major' negative impacts on people and nature across the country

The negative impacts of invasive species on biodiversity and people's livelihoods are known to be substantial (*established but incomplete*) {2.4}. Eleven (11) tree or shrub species, five fish species, two grass species, and one invertebrate species have been assessed to cause 'Major' or 'Massive' negative impacts at a national level (*established but incomplete*) {2.4}. This number is based on 36 assessments using the IUCN's Environmental Impact Classification for Alien Taxa methodology. Complementary assessments using risk analyses and findings from the IPBES IAS Assessment confirm that these species cause widespread harm across multiple sectors of society. The need for more studies and assessments on the impact of invasive species has been highlighted as a research priority for South Africa. The development and implementation of country-level species-specific management strategies informed by impact assessments would help protect biodiversity and ensure that ecosystem services essential to human wellbeing are maintained.

C) How sites are invaded and impacted

Head-line indicator	Trend	Notes
3. *Extent of area that suffers 'Major' impacts from invasions*	not reassessed	Biological invasions continue to cause impacts on biodiversity, ecosystem services, and human livelihoods by reducing South Africa`s water resources, degrading pasturelands, and exacerbating fire. These estimates, however, have not been recently revised.

Indicator	Trend	Confidence
3.1. *Alien species richness*	↗	low
3.2. *Relative invasive abundance*	↗	low
3.3. *Impact of invasions*	not reassessed	

C1: Invasions are distributed across the country including in protected areas

Invasive species are distributed across the country, with most broad-scale administrative units and biogeographical regions being invaded by a variety of taxa (*established but incomplete*) {3.1}. Most alien species are found in the Western Cape, Eastern Cape, and KwaZulu-Natal (*established but incomplete*) {3.1}, and around major urban centres (*established but incomplete*) {3.1}. This is likely because some species are commensal with humans, most were first introduced to urban centres, and because of greater sampling around urban areas (in particular there has been a rapid, recent increase in observations from citizen scientist platforms such iNaturalist) (*established but incomplete*) {3.1}. Robust and reliable monitoring systems that consistently track the distribution and abundance of alien species across the country are, however, lacking and thus the extent of invasions and the effectiveness of interventions cannot be assessed with a high degree of certainty. Data on the distribution and abundance of alien species need to be collected, collated, and integrated into national and global databases to facilitate the planning of interventions.

C2: Country-wide assessments indicate that invasive plant species are widespread, with several biomes and strategic water catchment areas experiencing substantial and increasing levels of invasion despite ongoing control efforts, except for taxa subjected to biological control

There are a few country-wide estimates for the relative abundance of invasive species. Estimates are available for invasive plants in protected areas managed by the South African National Parks and CapeNature and invasions in these protected areas were found to be minor to extensive (*well established*) {3.2}. The National Invasive Alien Plant Survey (2008–2023) provided estimates for selected plant species in terrestrial biomes and water catchment areas in South Africa. The Indian

Ocean Coastal Belt (11%), Fynbos (5%), Albany Thicket (3%), and Grassland (3%) biomes exhibited the highest proportions of invaded land. Six water catchment areas, which also serve as strategic water source areas, recorded relatively high invasive plant cover (4–10%).

C3: The impact of invasions on water resources, rangeland productivity, and biodiversity are severe; workflows to track these impacts are vital for prioritising interventions but are currently not in place

A handful of influential historical studies have indicated the severe impacts of invasions on water resources, rangeland productivity and biodiversity. These studies showed that: i) invasive trees use 3–5% of South Africa's surface water runoff each year; ii) invasive plants reduce the value of livestock production from natural rangelands by ZAR 340 million per year; and iii) biological invasions are responsible for 25% of all biodiversity loss, placing them as the largest impact to South Africa's biodiversity after cultivation and land degradation (*established but incomplete*) {3.3}. These negative impacts have not recently been reassessed, and workflows are required to improve the applicability and repeatability of the methods. Systematically quantifying and monitoring impacts on sites would facilitate the prioritisation of interventions; provide the justification for government investment to control biological invasions; and provide important background to communicate the severity of the issue to society.

D) What has been done to address the problem

Head-line indicator	Trend	Notes
4. *Level of success in managing invasions*	Not reassessed	Interventions are in place to address all facets of managing biological invasions, but funding is insufficient and declining. Despite local successes, invasions are increasing in extent and impact when assessed at a national scale.

Indicator	Trend	Confidence
4.1. *Quality of regulatory framework*	→	medium
4.2. *Money spent*	↘	medium
4.3. *Planning coverage*	→	medium
4.4. *Pathways treated*	→	low
4.5. *Species treated*	not assessed	NA
4.6. *Sites treated*	not assessed	NA
4.7. *Effectiveness of pathway treatments*	→	low
4.8. *Effectiveness of species treatments*	not assessed	NA
4.9. *Effectiveness of site treatments*	not assessed	NA

D1: Funding for the management of biological invasions has declined steeply

Funding provided by the DFFE's Working for Water programme was 54.5% less than in the preceding three years (*established*) {4.2}. National conservation agencies (South African National Parks and the Isimangaliso Agency) received 60% of this money, and as a result provincial conservation agencies experienced even steeper declines in funding, with some receiving no funding at all. In addition, funding from DFFE for research and implementation of biological control has been discontinued. A review of funding revealed that historic spending was 4% of that predicted as necessary for complete control to be achieved (*established but incomplete*) {4.2}. Additional funding will have to be found and efficiently used if significant impacts are to be avoided.

D2: South Africa has an innovative regulatory system to address biological invasions, but its implementation is limited

The National Environmental Management: Biodiversity Act's Alien and Invasive Species Regulations and Lists were revised in 2020 and came into effect in 2021. A process has been set up to ensure that regular, transparent changes informed by evidence can be made to the lists in future (*established but incomplete*) {4.1}. Capacity shortages have significantly restricted the government's ability to address most aspects requiring monitoring of compliance with the regulations. Monitoring the effectiveness of the regulations and engaging with stakeholders would help identify additional measures to improve the regulations and their acceptability.

D3: Intentional legal introductions are well regulated. The National Border Management Authority (BMA) became operational in 2023; but inspections for environmental threats have declined and illegal and accidental introductions continue

All legal introductions of new alien taxa require import permits, with permits issued only if the risks are demonstrated to be sufficiently low (*well established*) {4.1}. A major development to improve the integrated governance of South Africa's biosecurity and to prevent illegal and accidental introductions was the establishment of the BMA in 2020 (becoming fully operational in 2023) (*well established*) {4.4}. However, most pathways are either not managed or are partially managed (management focuses on specific species or is not national in scope), the effectiveness of pathway interventions is not monitored, and the number of inspections for environmental threats has declined since 2022 (*established but incomplete*) {4.4, 4.7}. Consequently, illegal and accidental introductions are continuing (*established but incomplete*) {1.2, 4.7}. Increasing capacity would help prevent future harmful introductions.

D4: The ongoing absence of monitoring systems limits South Africa's ability to improve the management of biological invasions

Many species have been subjected to ongoing control interventions but it is not possible to quantify the number of species involved as information is not reported. The area under management is also not consistently reported, precluding an estimation of the indicator for sites managed.

D5: Biological invasions have been effectively managed in a few cases, with biological control proving particularly successful

Invasive species have been brought under control in some cases (*established but incomplete*) {4.4–4.9}. In particular, investment into biological control of invasive species has resulted in at least 17 species being brought under permanent control and caused reductions in many other invasions (*well established*) {4.8}. Several species that are under biological control have decreased in cover at a national level over 15 years, while all other surveyed species that were not subjected to biological control have increased in cover despite ongoing mechanical and chemical control efforts. From these studies it is clear that effective control options are often available, but are reliant on sufficient resources to implement them. Interventions aimed at preventing the introduction of new invasive species, and eradicating or controlling those that have already become established, will deliver positive returns on investment, provided that they are implemented timeously and efficiently. Investments in control are economically justified in terms of avoided costs. Biological control can deliver particularly effective control. Given that funding will remain inadequate, it is important to prioritise those interventions that will have the greatest impact, so as to avoid ongoing increases in negative impacts.

E) Monitoring the status and management of biological invasions in South Africa in the context of what is needed to improve the effectiveness of interventions

E1: South Africa has a sophisticated range of processes to address biological invasions but the monitoring of these is currently insufficient to evaluate their effectiveness

[details and links to be added in the final report, including on gaps in the collection, collation, and flow of information that if filled would allow for interventions to be evaluated; and in light of the results of the survey questionnaire]

E2: Integrated governance will be crucial to improve the effectiveness of interventions

[details and links to be added in the final report; linking to the 2023 IPBES IAS Assessment]

Noteworthy invasions (2023–2025)

The invasions noted below are indicative of invasions in South Africa over the period covered by the report. This selection was made by the status report team and is not intended to imply that these taxa must be prioritised for management.

***Fusarium oxysporum* f.sp. *canariensis* (Fusarium wilt)**

Fusarium wilt, a plant disease caused by *Fusarium oxysporum* f.sp. *canariensis*, was first recorded in South Africa from samples taken in November 2023 from three ornamental *Phoenix canariensis* (Canary Island date palms) individuals displaying symptoms at the V&A Waterfront in Cape Town (Balocchi et al. 2024). Believed to be a recent introduction, Fusarium wilt is most often spread through the movement of contaminated plant material, and the use of contaminated tools. A second plant pathogen, *Nalanthamala vermoesenii*, was also identified for the first time in South Africa from the same samples. This pathogen can cause pink rot disease in a diversity of palms, however, it is often a secondary infection, associated with other primary and more serious diseases such as Fusarium wilt. There is no known effective treatment for Fusarium wilt and infected palms inevitably die. While *P. canariensis*, an alien ornamental in South Africa, is the main host for Fusarium wilt, other palms used as ornamentals [*P. sylvestris* (silver date palm)] and in agriculture [*P. dactylifera* (date palm)] are also susceptible, so too is the native species *P. reclinata* (wild date palm).

An ornamental palm showing symptoms of Fusarium wilt at the V&A Waterfront in Cape Town—Paul Barker

***Amathia verticillata* (spaghetti bryozoan)**

The alien marine bryozoan *Amathia verticillata* was first discovered on a jetty in the Langebaan Lagoon Marine Protected Area in November 2023 (Ackland et al. 2025). *Amathia verticillata* is likely native to the Caribbean Sea and is invasive in many parts of the world. *Amathia verticillata* probably arrived within Saldanha Bay via biofouling, and subsequently spread through fragmentation. It is now abundant at the head of the tidal lagoon and has been found in meadows of the endangered seagrass *Zostera capensis*. As the species has caused mass mortality in seagrass beds in parts of the world where it is invasive, its overlapping distribution with *Z. capensis* within Langebaan Lagoon is a cause for concern.

Amathia verticillata (spaghetti bryozoan) on Kraaibaai West Coast National Park Jetty—Sarah Ackland

Membranipora membranacea (sea mat)

A second alien marine bryozoan was identified in March 2024 on heavily encrusted kelp that washed up on Muizenberg beach in False Bay (Steyn and Robinson 2025). This bryozoan is native to Europe and was likely introduced through shipping – either through hull fouling or the release of ballast water (cf. Harrower et al. 2018 for the definition of these pathways). Kelp encrusted with this bryozoan washed up again in October 2024, suggesting that *M. membranacea* is established within the bay. The species has invaded kelp forests in the north-west Atlantic, where it has caused mass kelp mortality and the loss of entire kelp forests, with cascading effects on food webs and ecosystem functioning. Of particular concern are the kelp forests within Table Mountain National Park Marine Protected Area, which has been established precisely to protect such ecosystems.

Membranipora membranacea (sea mat) encrusting *Ecklonia maxima* washed up on Muizenberg beach in Cape Town—Clara Steyn

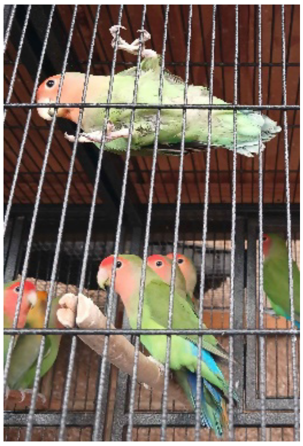
Pinus species (pines)

Pines have historically been extensively planted for forestry across the Cape Floristic Region (CFR). Escapes from these plantings (termed ‘wilding’ pines) have invaded large areas—over 900 km^2 in the CFR mainly of *Pinus pinaster* (cluster pine) and *P. radiata* (Monterey pine). These invasions pose significant threats to water resources and the CFR’s unique biodiversity, and increase the risk of damaging wildfires. Pines in the Cape are a classic example of conflict species that can deliver benefits and cause harm. A recent review (Martin et al. 2025) identified several opportunities to sustainably accommodate these trees, including deploying biological control, using less invasive hybrids, practicing triage by prioritising areas for focussed interventions, and improving compliance with regulations. Ensuring optimal outcomes will remain challenging.

Pine trees (*Pinus* species) in the Cape Floristic Region—Andrew Turner

Agapornis species (lovebirds)

Lovebirds are pretty, affectionate parrots; they are the most popular parrots in the global bird trade (Chan et al. 2021). South Africa is an important global player in the trade of lovebirds with significant large-scale breeding operations in the country (Emre Can et al. 2019; Chan et al. 2021; Shivambu et al. 2024b), although the socio-economic benefits have not yet been quantified. *Agapornis* species that are frequently exported or sold include alien species like *A. fischeri* (Fischer's lovebird) and *A. personatus* (yellow-collared lovebird), and the native species *A. roseicollis* (rosy-faced lovebird). Of concern, however, are records from social media (Shivambu et al. 2024a) and citizen science platforms (e.g., iNaturalist) that show lovebirds escaping or being released from captivity, with some populations likely to have established, including native-alien populations of *A. roseicollis*. Alien *Agapornis* species can hybridise with the native *A. roseicollis*. Stakeholder engagement with breeders and traders, particularly around the threat of hybridisation with native species is needed, and the option for permitting under the A&IS Regulations could be explored (cf. Table S4.1).



The native lovebird *Agapornis roseicollis* (rosy-faced lovebird) for sale in South Africa—Katelyn Faulkner

Drosophila suzukii (spotted wing drosophila)

Drosophila suzukii, a fruit fly native to Asia, has been introduced to many parts of the world, where it is a significant agricultural pest, causing damage to unripe berries and stone fruits. Due to its potential to invade and the associated economic risks, a pro-active survey was initiated in South Africa in 2021 (Steyn et al. 2025). The survey was funding by Hortgro and the South African Table Grape Industry, in collaboration with Insect Science, and comprised a network of over 70 traps placed in the main fruit growing areas of the Western Cape (Steyn et al. 2025). The pest was eventually recorded, however, from a trap opportunistically placed in April 2022 near a farm office in Misgund, Eastern Cape (Steyn et al. 2025). *Drosophila suzukii* has subsequently been recorded in eight provinces, including the Western Cape (Steyn et al. 2025). The rapid action taken following the detection of *D. suzukii*, such as the initiation of a national multi-industry trapping network and the establishment of the Monitoring Centre of Excellence at FruitFly Africa, aims to ensure the pest is kept under control and any impacts reduced.

Invasions in the Table Mountain National Park

Alien plant invasions have been managed in the Table Mountain National Park (TMNP) since the 1940s (Macdonald et al. 1986). The TMNP has received generous funding from the Working for Water programme since 1995—with ZAR 115 million (unadjusted for inflation) spent 2010–2022; and 22 875 ha treated (the whole of the TMNP is 24 500 ha) 2002–2020 (with an average of 4.2 follow up treatments). This level of funding has resulted in good progress towards reducing invasions to a level that can be maintained sustainably (Cheney et al. 2020). This example shows that management can be effective if funding is sustained, though providing similar levels of funding to target other protected areas will be challenging [cf. amounts spent on provincial nature reserves in the Cape Floristic Region (van Wilgen et al. 2025)].

Effective control of alien plants in the Table Mountain National Park—Nicola van Wilgen

Introductory Chapter: Processes used to construct this report

Lead authors: John R. Wilson, Tsungai A. Zengeya, Katelyn T. Faulkner, Brian W. van Wilgen, Masingitla P. Mtileni

0.1. Background, context, and process

0.1.1. The importance of biological invasions to South Africa

Biological invasions are amongst the leading causes of global change—they have had profound negative impacts on people and nature for centuries; are currently a significant drain on South Africa's economy and are negatively impacting native biodiversity; and pose a major threat to both the quality of life of future generations and the globally unique flora and fauna that are an integral part of this country. The problem is complex and set to grow. Invasive species come from many different taxa, invade different habitats, and cause various types of impacts sometimes in ways which are not yet fully understood but that will have profound effects on the ability of ecosystems to deliver services to people.

Thankfully, however, targeted interventions can be highly cost-effective, and so, while interventions can be complicated and costly, by working together as a society we can protect our biodiversity and natural capital from biological invasions (cf. IPBES 2023). The nature of the impacts and the types of responses needed mean that biological invasions are a significant cross-cutting issue for South Africa that is managed by a range of stakeholders using a variety of approaches. This requires integrated governance, and relies on mechanisms to assess progress at a strategic level (i.e., a status report; cf. Chapter 5).

0.1.2. The mandate, purpose, independence, and structure of the fourth status report

The issue of biological invasions has received significant recent global attention with the release of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services's 'Thematic Assessment Report on Invasive Alien Species and their control' in September 2023 (IPBES, 2023[8]; hereafter the IPBES IAS Assessment); and the discussion around international targets for biodiversity, specifically the Kunming-Montreal Global Biodiversity Framework (GBF) Target 6 on biological invasions.

> *Target 6: Reduce the Introduction of Invasive Alien Species by 50% and Minimize Their Impact*
>
> *Eliminate, minimize, reduce and or mitigate the impacts of invasive alien species on biodiversity and ecosystem services by identifying and managing pathways of the introduction of alien species,*

[8] https://www.ipbes.net/ias

preventing the introduction and establishment of priority invasive alien species, reducing the rates of introduction and establishment of other known or potential invasive alien species by at least 50 per cent, by 2030, eradicating or controlling invasive alien species especially in priority sites, such as islands. [9]

The fourth status report sits firmly within this context, but the specific mandate for the status report originally arose from section 11 of the A&IS Regulations of 2014 that were published 1 August 2014 and promulgated in October 2014. Revised regulations were published 18 September 2020 and promulgated 1 March 2021, with section 13 stating:

(1) The Institute[10] or a body designated by the Institute must, for the purpose of reporting as contemplated in section 11(1)(a)(iii) of the Act, submit a report on the status of listed invasive species to the Minister within three years of the date on which these regulations come into effect, and at least every three years thereafter[11].

(2) A report contemplated in sub-regulation (1) must contain a summary and assessment of—

(a) the status of listed invasive species and other species that have been subjected to a risk assessment; and

(b) the effectiveness of these regulations and control measures based inter alia on information from—

(i) notifications received from owners of land regarding listed invasive species occurring on their land;

(ii) permits issued for listed invasive species;

(iii) Invasive Species Monitoring, Control and Eradication Plans received from organs of state and management authorities of protected areas; and

(iv) emergency interventions and enforcement actions involving listed invasive species.

(3) In preparing a report contemplated in sub-regulation (1), the Institute must carry out the research and monitoring necessary to identify the matters contemplated in sub-regulation (2).

More broadly, however, the status report aims to strengthen the links between research, policy, and management by detailing the current status and providing support to decision makers that is policy relevant but not policy prescriptive (see Chapter 5). In this sense, the status report will play an important role evaluating progress towards the goals of South Africa's forthcoming national strategy on biological invasions[12]. This status report is produced by SANBI in collaboration with many partners

---

[9]https://www.cbd.int/gbf/targets/6

[10]The South African National Biodiversity Institute (SANBI)

[11]As the latest version of the regulations came into effect in March 2021, this would imply by March 2027, but to maintain triennial cycles in line with the original 2014 A&IS Regulations, the date is taken to be October 2026. It takes time to compile, revise, and produce these reports. Therefore, a cut-off date is needed, after which no new data are considered. This fourth report is thus entitled 'The status of biological invasions and their management in South Africa in 2025', as it reports on the status up to the end of 2025, and published in 2026.

[12]South Africa's draft National Invasive Species Strategy and Action Plan (NISSAP) is discussed in Section 4.1

(primarily the CIB), but the intention is for the report to be an independent assessment (see S0.1 for a discussion on measures taken in an effect to ensure the independence of the report).

Reports have been produced every three years based on data up to the end of December 2016, 2019, and 2022 respectively. The reports are structured around an indicator framework that explicitly considers biological invasions in terms of pathways, species, sites, and interventions (Figure 0.2). This indicator framework provides a transparent and objective method for the establishment of baselines against which to assess trends, set realistic management targets, highlight important gaps in the evidence needed to support decision-making, and support international reporting (see Section 5.7).

The report is comprised of chapters based on this framework (i.e., on pathways, species, sites, and interventions). Each chapter starts with key findings, then for each indicator a summary of the status and then a discussion of key changes and recent noteworthy events, often with case studies in the form of text boxes. In addition, for this report, an additional chapter specifically focusses on monitoring. The purpose of the chapter is to highlight what monitoring is on-going and what is required to better understand and manage biological invasions in South Africa. The report concludes with a chapter on key gaps. Much of the detail underlying the production of the report is contained within the appendices and supplementary material available on-line (links to them are on the last page of the report).

Like the IPBES assessments, the status report also presents key messages with an evaluation of the confidence with which each message is made and links through to relevant material in the chapters that provides the underlying evidence. A new feature in this fourth report is a section on noteworthy invasions. These are both new species recently found in South Africa and those for which new information has become available highlighting impacts or successful control measures.

0.1.3. Synopsis of previous reports and the major goals of the previous reports

Over the production of the preceding status reports, there have been major improvements in how data are presented, how changes are tracked (Table S0.1), and the degree to which the information presented is consistent with international best practice. The development of documented and repeatable workflows has ensured that it is now clear why species are included on the list of alien taxa, and the workflows facilitate reviews and updates. The focus for the next phase is to ensure that all historical data sources are incorporated into the list of alien taxa and to put systems in place to incorporate new information as it becomes available. The process of developing the report is discussed in the context of the list of alien taxa presented in Zengeya et al. (in press). In the following, we provide a synopsis of the different reports noting the key changes made for each report (cf. Table S1 of Zengeya et al. 2025).

The first report was largely based on the mandated requirement for reporting on alien taxa listed under the A&IS Regulations. But as it was the first such report anywhere in the world, much of the structure had to be developed. Following the FAIR data principles, the information produced was 'Findable' and 'Reusable' but was not 'Accessible' or 'Interoperable'. The primary goals[13] of the first report were to:

- ✓ Initiate the process of compiling the report
- ✓ Develop indicators and test whether they were fit for the purpose
- ✓ Initiate the process for sourcing information and engaging specialist contributors

A major lesson during writing the second report was the importance of having processes so that updates to reports can be made more easily and so that changes could be tracked. The second report had a greater focus on specifying sources of information and ensuring information was 'Accessible' and 'Interoperable'. The primary goals of the second report were to:

- ✓ Ensure data were curated in a manner that was FAIR and tidy
- ✓ Adjust indicators and protocols
- ✓ Develop a method to track changes over time
- o Test the indicators (this was addressed in the third report, specifically for the Prince Edward Islands)
- o Expand efforts to access data (this is on-going)

When the third report was produced, standards had been tested and processes more clearly codified. There was greater focus on making the data tidy and FAIR, including through systematic inclusion of the evidence underpinning the information. Information was not carried over from previous reports if supporting evidence was not available. A greater number of sources were incorporated. The primary goals of the third report were to:

- ✓ Produce a defensible list of alien taxa
- ✓ Pilot indicators for selected case studies
- o Contribute to the national strategy on biological invasions [this was achieved within the relevant time-frame, but will be on-going until the National Invasive Species Strategy and

[13] fully achieved (✓), partially achieved (○)

Action Plan (NISSAP) is completed at which point the goal will be to provide a strategic assessment of the NISSAP]

- Assess impacts for key taxa [this is an on-going process linked both to the process of producing risk analyses in support of the A&IS Lists (see Section 4.1) and to developing international best practice]
- Develop processes to work on impacts on sites (it was found to be very difficult to replicate previous studies estimating site-level impacts, see Section 3.3; this is a significant on-going gap, see Chapter 6)
- Develop processes to get estimates of the effectiveness of management (data tracking effectiveness are scarce and information that has been collated is often very hard to interpret in terms of invasion-specific outcomes, see Sections 4.7–4.9; specific focus is needed on this from the ground up, Chapter 5)

Table 0.1. The specific goals for this fourth report. These goals are in addition to meeting the mandated requirements and building on the previous goals.

Goal	Details	Main sections where the issue is addressed
Review indicators nationally and globally to improve national processes	South Africa has an international obligation to report to the CBD on progress on biological invasions. Indicators are being developed to evaluate progress towards the targets of the Kunming-Montreal Global Biodiversity Framework (KM-GBF) with desirable properties of indicators proposed. The indicator framework used in this report needs to be evaluated in these contexts and considering experiences to date.	Section 0.2.2 Section 5.7
Review of gaps identified as part of IPBES IAS Assessment	There is a need to evaluate issues raised in the IPBES IAS Assessment within the South African context and to learn from the IPBES process.	Section 0.3 Chapter 6
Stakeholder consultation to improve the report	Given that this is the fourth report, many of the systems have been tested and revised. It is important at this stage to reflect on how the reports are being used, and what end users would like the reports to address.	Section 5.2
Review and update the list of alien taxa	Ensure taxonomy and nomenclature are clearly specified. Incorporate more data sources. Develop processes to integrate with international and national databases.	Sections 0.4, 2.1
Develop workflows for selected indicators	While some of the report processes have already been codified as workflows, a sustainable repeatable reporting process will require more systems to be set up particularly if the goal of developing a dashboard is to be achieved.	Section 0.4 Appendix 2
Integrate biodiversity data into report processes	Ensure information can be readily incorporated and analysed. Specifically this was addressed by trialling data pipelines developed as part of the B-Cubed project[14].	Section 5.3 Box 2.2

[14] https://b-cubed.eu/

0.1.4. Aspects not covered

The aspects not covered are similar to those in previous reports. Four broad aspects not covered are highlighted here.

As the status report's primary function is to report on environmental issues, there is a limited focus on the socio-economic problems caused by biological invasions. The most damaging invasive species are human diseases. These are not included in this report. Similarly, pests and weeds are a major threat to food security, a central goal of sustainable development, but are not within this report's remit unless such taxa also impact on, or threaten, natural ecosystems. Saying that, there is an increasing recognition that biodiversity and health are inextricably linked. Moreover, in some situations, interventions are only effective if environmental health, animal health, plant health, and human health are considered in concert (the One Health and One Biosecurity approaches; see Box 1.2). Without well-established metrics and indicators to monitor such linkages, and in the absence of detailed cross-cutting case studies that explicitly consider biological invasions, these issues are not addressed in any depth in this report. If these reports are to holistically address biological invasions, future reports will need to jointly consider the status and management of biological invasions that affect all sectors.

Secondly, there is a suite of native species that can have undesirable impacts that are similar to the impacts caused by alien species, but which are precipitated by changes in land use or other aspects of global change. Examples include bush encroachment by native plants and the spread of many native bird species into urban areas. These taxa can present problems that require management, but such management needs to be in the context of the taxa being within their native ranges. The report does, however, cover taxa that are native to one part of South Africa but alien to another part of the country [as defined by Nelufule et al. (2022)].

Thirdly, the last report included a section (Chapter 5) on the status and management of biological invasions on the Prince Edward Islands (the PEIs: Marion Island and Prince Edward Island). The chapter was subsequently expanded, used as a test of the indicator framework, and published (Fernández Winzer et al. 2025b). One recommendation was that regular (annual) updates on the status of biological invasions and their management on the PEIs are needed and should be led by those responsible for the islands. As such, this report does not include an update on the situation on the PEIs, but such an update might be appropriate for this report series if reports are produced less often (e.g., every decade).

Finally, it is important to note that the national status report is intended to be policy relevant but not policy prescriptive. As such, specific recommendations are not provided. The focus is on reporting on the status with an assessment of what is preventing improvements in the status or in how the status is assessed, rather than outlining actions that are necessary to achieve a specific goal (cf. the NISSAP and Chapter 5).

0.1.5. Road map for this report

The process to compile the report was broadly similar to the previous reports (Figure 0.1), with largely the same core team, consisting of the South African National Biodiversity Institute as the lead institute, the Centre for Invasion Biology as a collaborating partner, and various managers, researchers, private individuals, and institutions providing information and comments on draft reports.

Review of release of 3rd report and essential workflows identified: The SANBI-CIB drafting team reflected on the report launch and how it was received, and in particular identified the need for closer engagement with affected government departments. It was noted that by providing an opportunity to evaluate the findings and develop appropriate responses ahead of the report launch, affected agencies would be in a better position to respond to and uptake the findings. The drafting team also identified essential workflows for the production of the report that needed to be set up during this report cycle (Section 0.4).

A reference and advisory committee (RAC): a RAC was established to provide oversight of the process and review documents produced. The first meeting of the RAC was on 30 July 2025 at which a zero-order draft (consisting of an annotated table of contents) was approved. The first draft of the status report was sent to the RAC on 30 September 2025[15] for review – they were given a month to comment. The RAC evaluated the status report team's responses to the comments received at the second meeting of the RAC on 5 December 2025. Following public review of the second draft, a final draft was produced and sent to the RAC on 31 March 2026. The RAC met for a final time in April 2026 to discuss the final draft, and particularly the key messages. The Chair of the RAC reviewed how the comments received during all rounds of review had been addressed, i.e., acted in a review editor role.

Collate and review available information: Information was incorporated into the report primarily from published literature and unpublished information provided by stakeholders. Information contained in the report is based on data available to the report writing team as of the end of December 2025. As

[15]Throughout the draft versions of the report, the tense used is as it is intended to be in the final report, i.e., in the past tense rather than the future tense.

part of this report cycle, and to further develop the list of alien taxa as part of the report, three linked journal special issues on 'Developing lists of alien taxa in the Global South' were produced (Box 2.1).

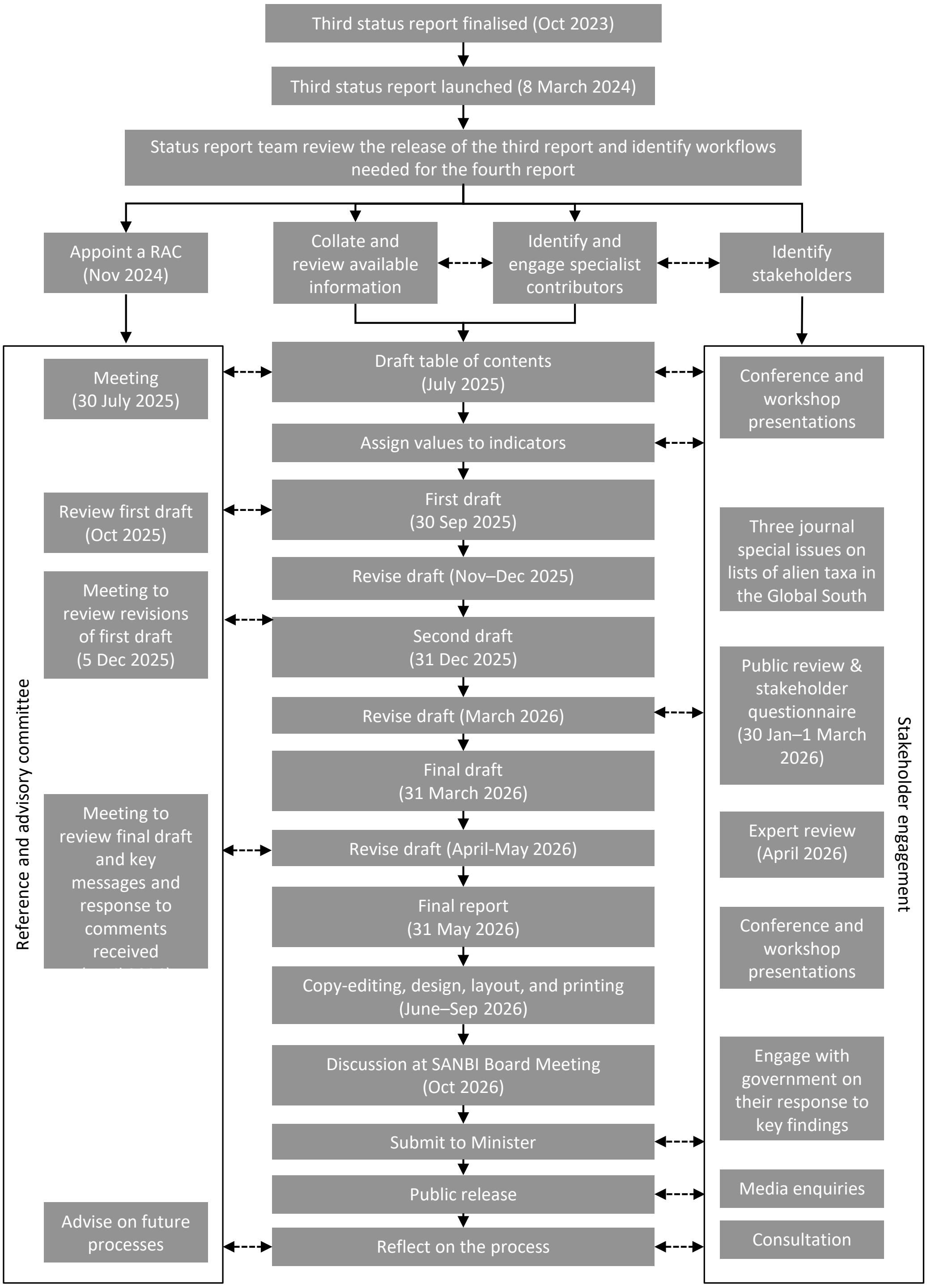


Figure 0.1. Key steps in the production of the report 'the Status of Biological Invasions and their Management in South Africa'. The Minister is the South African Minister of Forestry, Fisheries and the Environment; the RAC is the research and advisory committee; and SANBI is the South African National Biodiversity Institute.

Stakeholder engagement: Stakeholder engagement was an on-going process linked to the other activities. Initially the drafting team engaged directly with specialists to obtain information that was not readily accessible and identified stakeholders to be contacted for input and review. Stakeholders identified previously and those who provided comments on previous reports were asked for updates (see S0.3 for details and a draft letter). New potential contributors were contacted on an ad hoc basis as information became available and in response to the public consultation. Contributors came from academic institutions; research institutes and science councils; national, provincial, and local government departments and protected areas; and from private individuals who were interested and affected. Contributions from the identified stakeholders were in the form of data provision, commenting on drafts, and assisting with writing up case studies.

All feedback was recorded and the comments responded to in line with international best practice (IPBES 2018). The comments received and the responses from the status report drafting team were documented and are available for scrutiny from SANBI on request.

Public review and stakeholder questionnaire: The second draft was completed by the end of December 2025. Given it was not appropriate for the draft to be sent for review over the festive period, the draft was sent for public comment during the period 30 January to 1 March 2026. The request for review was submitted to: a South African list server on biological invasions (invasives@wordlink.co.za); heads of relevant national and provincial government departments; heads of relevant academic departments and institutions; and professional societies and forums (including the Royal Society of South Africa; the Akademie vir Wetenskap en Kuns; the Zoological, Entomological, and Botanical Societies; Birdlife South Africa; and the Wildlife and Environment Society of South Africa). A copy of the draft for public comment was attached to the formal notice and was available for download online (http://dx.doi.org/10.5281/zenodo.17697657). Comments were received from …[16].

In previous report cycles there have been multiple rounds of public review. This was largely as the structure of the report was still being formulated, and so the first round of comment was focussed on structural issues and what the report should include. The later round of public comment was focussed on the specifics of the content. To engage stakeholders with the broader structure and purpose of the report as well as guiding future reports, a questionnaire was circulated in parallel to the public review of the fourth report.

[16]the number of people and institutions commenting to be added later.

From finalisation to report release: The final draft was produced on 31 March 2026 and discussed with the RAC. All remaining content issues were concluded, and the report was finalised on 31 May 2026. The final report was sent in June 2026 to the SANBI Graphics team for copy-editing, layout, design, and printing. The report was then submitted to the SANBI Board in September 2026 for their consideration at a meeting in October 2026. After board approval, the SANBI CEO submitted the report to the Minister of Forestry, Fisheries and the Environment, and, at the same time, a copy of the report was submitted to the key national government departments that are responsible for addressing biological invasions (the DFFE, the BMA, and the DoA). This provided those departments with an opportunity to prepare for responding to media enquiries or public concerns and to seek clarification from the report drafting team as needed, noting that no changes could be made to the report during this period. To maximise publicity and media uptake of the report, the report is intended to be released to the public in early January 2027 in time for the fresh news cycle of the year though that is ultimately at the discretion of the Minister. As with previous reports, information will be submitted to the South African State of the Environment Report process (http://soer.environment.gov.za/soer/).

Reflect on the process: After the public release of the report, the status report team will consult key stakeholders including members of the RAC to reflect on the process used to compile the report and to identify areas of improvement for subsequent reports.

0.2. Indicators

This report is structured around 20 indicators and 4 high-level indicators (Figure 0.2; Wilson et al. 2018). The technical details on scoring the indicators and the high-level indicators are available in factsheets (Appendix 1) and the supplementary material to each chapter.

The indicator framework has been updated in two ways. First indicators are now assigned to categories according to the theory of change approach (Section 5.3), noting that the pathway indicators are of two types—those that are invasion-specific outcomes and those that are corresponding pathway-specific drivers that may affect these outcome indicators (e.g., '1.1. *Introduction pathway prominence*' potentially affects '1.2. *Introduction rates*'). There are many drivers that affect biological invasions (Hulme et al. 2023), and in future reports it might be desirable to evaluate how the drivers in South Africa interact to impact biological invasions. There is also the potential to link to other existing indicators (e.g., the 'Biodiversity Habitat Index' cf. https://geobon.org/ebvs/indicators/) that might be acting as drivers of invasion (e.g., by increasing habitat invasiblity).

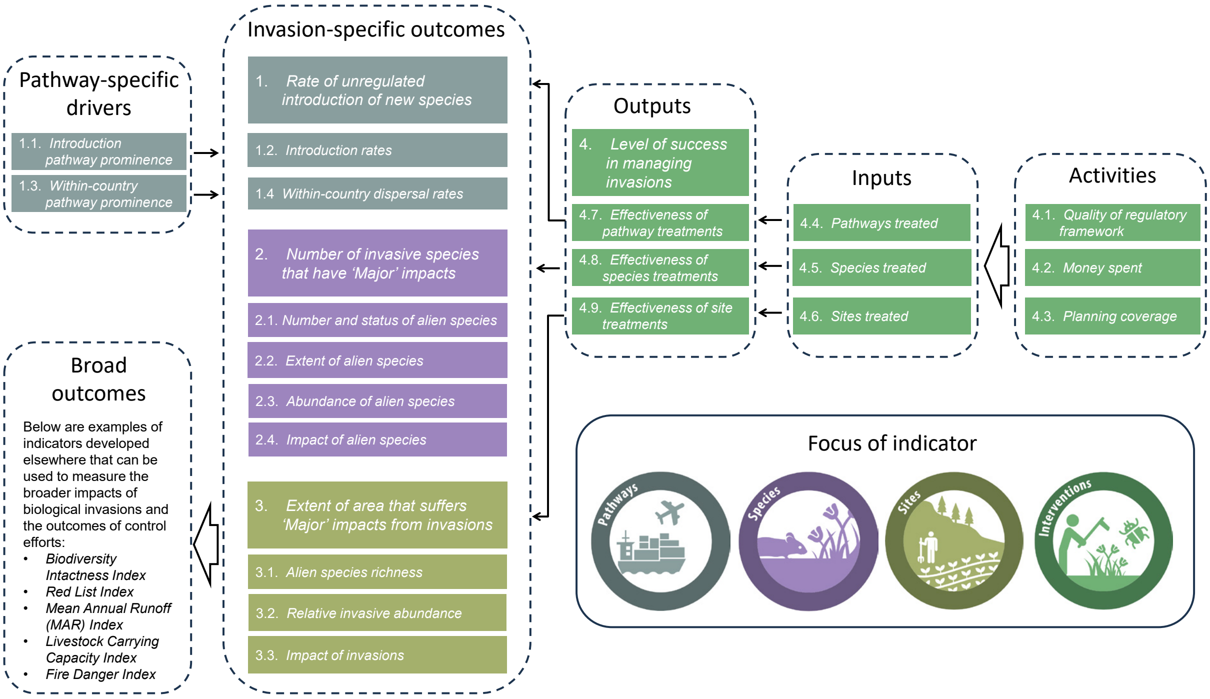


Figure 0.2. Indicator framework used in this report. This is based on Wilson et al. (2018) updated to link to the theory of change framework (see discussion in Section 5.3 and an example in Chapter 5). The thin arrow represents a close link between specific indicators, the broader arrows represent a link between all the indicators in a particular type and the indicators in another type. A factsheet for each indicator specified here is available in Appendix 1.

Second a link is made explicitly between the indicators on invasion-specific outcomes (that were developed and are used specifically for this report) and indicators of broader environmental and socio-economic outcomes that may be affected by biological invasions. The indicators related to broader outcomes are developed as part of other monitoring and reporting processes, but in some cases would be expected to be robust indicators of the value of successfully managing biological invasions [e.g., invasive trees significantly increased the fire danger index during the June 2017 wildfires in the southern Cape (Kraaij et al. 2018)]. As for the past reports, these broader outcome indicators are discussed in part (e.g., when discussing '3.3. *Impact of invasions*'), but a more systematic process of selection, inclusion, and discussion in this report will need to be a focus of future reports.

Notably, the baselines proposed in previous reports needed to be revised in some instances (e.g., due to errors in the original values). This means that it is not always appropriate to compare values between the reports, and in some cases the report calculated the values that should have been in previous reports. Changes over time from these revised baselines are presented and discussed in this report, and differences in the calculation methods used between the reports are noted in the supplementary material.

0.2.1. Indicator factsheets

Indicator factsheets were developed and published in Wilson et al. (2018) based on the guidelines of the Biodiversity Indicator Partnership (2011), with the addition of a section on how to define a confidence level for each metric. There are several additional enabling processes that are vital for successful interventions, specifically accessibility of data and information, research, organisational and human capacity, and public awareness and engagement. However, indicators for these are not included as they are not used for measuring the outputs or outcomes of the interventions.

For this report, the factsheets have been updated and revised (Appendix 1). In particular, examples of each indicator are based on those used in this report or previous reports. The type of each indicator is also now specified using two metrics: the DPSIR (driver, pressure, state, impact, and response) framework; and a 'Theory of Change' framework [input, process, output, outcome (invasion-specific), outcome (broader)]. Details of the latter are discussed in Chapter 5.

Vicente et al. (2022) developed eight desirable properties of indicators used to monitor biological invasions—established, spatially explicit, scalable, temporal, uncertainty appraisal, taxonomic representativeness, invasive alien species (IAS) specific, and reproducible. The indicator factsheets now also include an analysis of the degree to which each indicator adheres to these properties (see S0.4 for details of the methodology).

0.2.2. International indicators

The Kunming-Montreal Global Biodiversity Framework (K-MGBF) Target 6 has the following headline indicator.

- '*6.1 Rate of invasive alien species establishment*'. This indicator is similar to one of the high-level indicators in this report '*1. Rate of unregulated introduction of new species*'. However, the data used to calculate the headline indicator for Target 6 must take sampling effort into account otherwise misleading patterns will emerge (McGeoch et al. 2023). Data gaps exist (Section 6.4) and proxies of survey effort have not been routinely captured. Improved institutional co-ordination would assist (e.g., with the Department of Agriculture for new agricultural pest introductions). The indicator in South Africa's National Status Report on Biological Invasions differs from the headline indicator, work and capacity are required to bridge the gap, noting the stated concerns about the appropriateness of the indicator (see Section S0.6 for more details). For more details see the corresponding information on the GEO BON indicator '*Rate of invasive alien species establishment*' (https://geobon.org/ebvs/indicators/rate-of-invasive-alien-species-spread-indicator/).

There are several additional component indicators:

- '*Rate of invasive species impact and rate of impact*' is linked to the report indicator '*2.4 Impact of alien species*'. Processes are being developed to calculate the indicator based on work piloted in South Africa (Boulesnane-Guengant et al. 2025) and as part of the B-Cubed project (Chapter 5). Once developed these processes will be tested and applied in future reports.
- '*Rate of invasive alien species spread*' is linked to several of the indicators of the report '*1.3 Within-country pathway prominence*', '*1.4 Within-country dispersal rates*', and '*2.2. Extent of alien species*'
- '*Number of invasive alien species introduction events*' is linked to '*1.2 Introduction rates*'.

There are three complementary indicators:

- '*Number of invasive alien species on national lists as per the Global Register of Introduced and Invasive Species*'. There is a GRIIS page for South Africa published on GBIF (https://cloud.gbif.org/griis/resource?r=south-africa-griis-gbif) although this was last updated in 2020. A workflow will be developed to convert South Africa's national list into the GRIIS format and to stream-line the process for information to be fed through to update information on the GRIIS website.
- '*Trends in abundance, temporal occurrence and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (in relation to the main vectors and pathways of spreading of such species)*' this relates to '*3.1 Alien species richness*'
- '*Red List Index (impacts of invasive alien species)*' this is one metric used for the indicator '*3.3 Impact of invasions*'. The relationship between the Red Lists index and EICAT are also discussed in Van der Colff et al. (2020).

0.3. IPBES IAS Assessment

The implications of the IPBES IAS Assessment for South Africa were recently reviewed by Wilson et al. (2025). Most of the key messages of the IPBES IAS Assessment resonate strongly with the perceived situation in South Africa, with three differences highlighted: a) South Africa has shown significant progress with managing and regulating biological invasions (e.g., Wilson and Kumschick 2024); b) the available evidence does not suggest that rates of introduction have increased drastically over the past few decades (see Section 1.2); and c) there is only one example of a successful nationwide eradication to date (Davies et al. 2020; Wilson et al. 2013; cf. Section 4.8). However, in line with the findings of this report, the evidence base was scored as low in many cases.

The following is part of the summary of Wilson et al. (2025):

Trends and status of biological invasions in South Africa are similar to those seen globally, but there are some distinct local nuances. South Africa has: 1) a long history of invasions with negative impacts caused especially by invasive trees and freshwater fishes, whilst invasive marine invertebrates have transformed large parts of the coastline; 2) a long history of control (biological control was first implemented in 1913) with large-scale state-run invasive species management programmes currently in place; 3) a comprehensive regulatory system (e.g., that provides provision for beneficial invasive species to be used under permits); 4) relatively high levels of awareness and engagement (at least among some stakeholder groups); and 5) a well-connected community of practice. Efforts to limit introductions (intentional or unintentional) are, however, difficult given South Africa's extensive and porous borders and the pressing need to increase trade. Regulatory and implementation efforts aimed at prevention are improving, with the newly established Border Management Authority aiming to integrate biosecurity interventions at ports of entry. Such integrated governance is, we argue, needed more broadly if affected sectors, society groups and stakeholders are to be effectively included in decision-making and management. A more systematic flow of information from observation to action is essential, as is better feedback between research, policy and implementation at all scales. Biological invasions will continue to pose threats, but many of these can be effectively mitigated through focussed interventions. Co-ordinating such interventions in the context of other cross-cutting global change challenges and initiatives is a cost-effective way of protecting and improving livelihoods, human health, quality of life and biodiversity.

0.4. Workflows

A goal of this report is to develop workflows for key report processes (Table 0.2). In so doing, the intention is for the report process to become sustainable and repeatable. The longer-term plan is to develop an on-line resource with indicator values updated as soon as new information becomes available (i.e., a dashboard). Such a dashboard can be used to produce reports on demand and form the basis of both semi-automated annual reports and less frequent comprehensive reports; noting that such reporting will need to be in line with regulatory requirements—currently triennial reports are mandated. The workflows are also designed to ensure data are FAIR[17] and tidy (Wickham 2014) in line with international best practice (IPBES 2018) and to facilitate the integration with other national and international processes.

[17] Findable, Accessible, Interoperable, and Reusable

Table 0.2. Summary of workflows developed or proposed as part of the national status reports on biological invasions and their management in South Africa. [Note: as several of the workflows are still under development, updated versions of all workflows have not been included as part of this draft report, the current link to Appendix 2 points to the workflows outlines in SANBI and CIB (2023)].

Workflow	**Description**	**Status**
Introduction pathway prominence	The process needed to gather information on indicator 1.1. *Introduction pathway prominence* that addresses which pathways are operating into South Africa and estimates the volume of transport along each pathway	Updated and automated where possible
Tracking data sources and adding data as published	The process to collate all information sources used in the production of the report, categorise them according to the nature of the source, and ensure sources are presented in a manner that is easy to access. The steps to systematically check for new sources of information, evaluate them, and, as appropriate, filter through either to the '*Adding alien taxa and enrichment data to the species list*' workflow or to assign values to other indicators are outlined. This workflow does not currently include processes to contact stakeholders for information (cf. Figure 0.1 and Section S0.3)	Updated and expanded
Adding alien taxa and enrichment data to the species list	The list of alien taxa includes 38 variables (Zengeya et al. 2025, in press), with information for any one taxon coming from multiple, sometimes conflicting sources. A process has been developed to evaluate data sources, translate them into the variables used in the list of alien taxa (intermediate files are created and stored), and to update the list itself	Updated
The permit database	The DFFE issues permits to conduct otherwise prohibited activities on taxa listed under the A&IS Regulations. The workflow explains the steps to transfer the information in the DFFE's database of permits into a tidy, redacted form that can be published	Updated
Money spent	Information on the amount of money spent on interventions to address biological invasions is sourced primarily from various government departments	Revised
Alien taxa impact assessment	Based on the IUCN's EICAT scheme and the SEICAT scheme, the workflow outlines the process to collate published information and interpret it in a standardised format that can be incorporated into the list of alien taxa	Not updated
Workflow to check sources for new introductions	Various checks are done to identify taxa which have been recorded as present in the country since the last report. The workflow also outlines the process to incorporate such information into the list of alien taxa and aims to link to other processes for addressing new detections	New
Species treated	Information is sourced primarily from various government departments on which taxa have been subjected to interventions	New
Introduction status and degreeOfEstablishment	Information on the stage at which an alien taxon is along the introduction-establishment-invasion continuum within South Africa is gathered and systematically interpreted along with the data (this is a specific routine within the '*Adding alien taxa and enrichment data to the species list*' workflow)	New
Integration with the National Biodiversity Assessment (NBA)	To ensure information can flow between reports. The intention is to include data translation tables linked to how data are presented in the status report to how data are presented in the NBA	Future

Workflow	Description	Status
Integration with the Global Biodiversity Information Facility (GBIF) and the Global Register of Introduced and Invasive Species (GRIIS)	To ensure information can flow between the national status report and international databases. The intention is to include data translation tables linked to how data are presented in the status report to how data are presented in the GBIF and GRIIS	Future
Sourcing, capturing and reporting information for the Prince Edward Islands (PEIs)	Workflow to populate the indicators for the PEIs. The workflow was part of Chapter 5 of the third report (SANBI and CIB, 2023)	Not updated as not used in this report

Some of these workflows required specific protocols where the intention is for these to be applied outside of the report. For example, a protocol has been set up to evaluate whether a taxon is absent or present in South Africa in cases where the evidence is ambiguous (Matthys et al. 2025).

1. Pathways

Lead author: Katelyn T. Faulkner

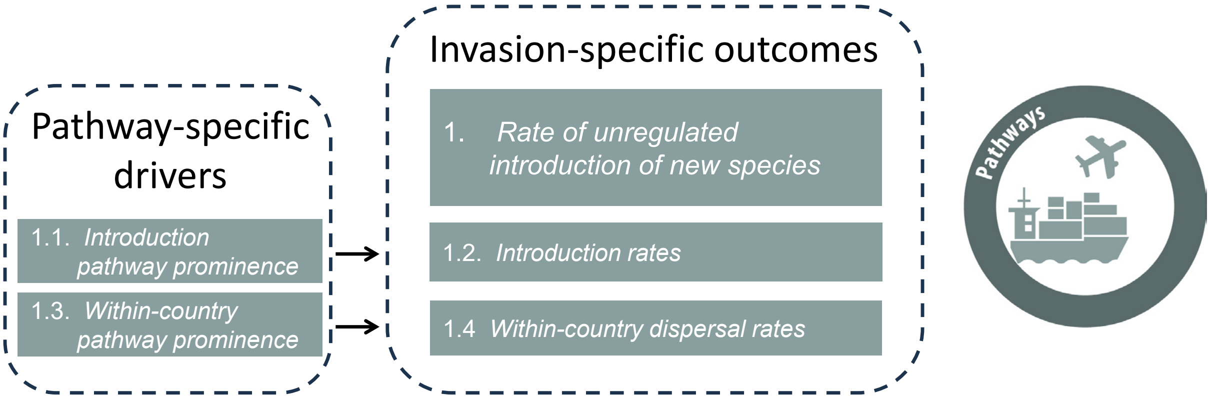
Contributing authors: Pia Addison, Felipe Balocchi, Sonja Coerze, Grant Martin, Wilma Nel, Iva Přikrylová, Davina Saccaggi, John R. Wilson, Costas Zachariades

Findings for pathways

- There continue to be opportunities for introductions through a wide range of pathways, with no qualitative changes to these opportunities. Quantitative increases for some pathways represent a return to the levels of activity experienced prior to the COVID 19 pandemic.
- The size and diversity of the aquarium trade, and the range of introduction opportunities it provides has been highlighted by recent research.
- New alien species that have been illegally or accidentally introduced continue to be detected every year, with the rate of introduction remaining stable (~four new species per year).
- Alien species have been introduced through a wide variety of pathways, but besides biological control agents, all new alien taxa that have been recorded in the last three years are likely to have been accidentally introduced, including several plant parasites, and contaminants of the aquarium trade. Intentional illegal introductions are still a concern.
- Many pathways provide opportunities for within-country dispersal. However, the magnitude and role of most pathways is not known. For those pathways for which data were obtained, within-country activity has returned to pre-pandemic levels.
- Alien taxa are dispersing within the country in a myriad of ways. Recent studies show within-country movement is a mix/combination of natural dispersal (e.g., self-propelled and mediated by vertebrate vectors) and human-mediated dispersal (e.g., with contaminated soil and plants, though biofouling on ships or boats, and the formal and informal plant trade).
- As an example of these trends, South Africa plays a large role in the international pet trade, breeding animals (particularly alien birds) for export and local use. Records from social media show alien pet birds are escaping from captivity.

Gaps for pathways

- There are major gaps in our knowledge on *introduction rates*, with pathways and dates of introduction missing for many introduced taxa, particularly plants and fungi. Estimates or useful proxies of search effort are required for more reliable estimates of rate of introduction and for reporting on Target 6 of the GBF
- Insufficient information on how taxa are moved or are moving within the country



For all pathway indicators, the pathway classification framework of the Convention on Biological Diversity was used (CBD 2014). The pathways are shown in Figure 1.1 and details on the pathways, including descriptions and definitions, are provided in Harrower et al. (2018). Specific details of values are provided in Appendix 5 and methodological changes from previous reports and details of how the calculations were made are outlined in the Supplementary Material (e.g., Table S1.1).

1.1. *Introduction pathway prominence*

Introduction pathway prominence assesses, based on socio-economic data, the opportunities available for alien organisms to be introduced to South Africa from other countries. This indicator does not consider how many introductions these opportunities have resulted in. If effective biosecurity is in place, then a large or increasing *introduction pathway prominence* (e.g., increasing food imports) is not a concern in terms of biological invasions.

There have been no changes to *introduction pathway prominence* (Figure 1.1). There have, however, been some noteworthy events and research:

In 2023, one of the official ports of entry between Botswana and South Africa (Zanzinbar), was withdrawn (Figure 4.3). South Africa still has many official ports of entry - eight maritime ports, ten airports and 53 land border posts – through which people, goods, and transport vessels can officially enter the country (Figure 4.3).

Aquaculture has been promoted over recent years (Van Deventer et al. 2019), and production increased year-on-year between 2015 and 2022, however, there was a 24% decline in production between 2022 and 2023 (Figure S1.3). This change may be temporary and thus was not considered to be a qualitative change to the indicator (*introduction pathway prominence* remains 'Moderate').

Between the 2022/2023 and 2024/2025 financial years, there was a ~24% increase in the number of aircraft arriving from regional or international destinations (Figure S1.16). Similarly, there was a 39% increase in the number of people entering South Africa between 2022 and 2023 (Figure S1.19). These recent increases represent a return to levels of activity prior to the COVID 19 pandemic and do not constitute a change in the indicator (*introduction pathway prominence* remains 'Moderate' for the airplane pathway, and 'Major' for the people and their luggage pathway).

Recent research on the ornamental plant trade in southern Africa has shown that it is transboundary in nature, with South Africa acting as the leading supplier for the sub-region (Rodríguez-Cala et al. 2025a). Nonetheless, the *introduction pathway prominence* for the ornamental pathway remains 'Moderate'.

The size and diversity of the aquarium trade; and its potential role in facilitating both fish introductions and invasions, and introduction and spread of fish parasites has been highlighted. A national survey of the alien ornamental fish sold at pet shops showed that at least 312 fish species belonging to 77 families and 182 genera are traded (Vezi et al. 2024). Notably, the number of species in the trade is similar to that recorded in trade in large, developed regions, such as Europe, the USA, and Canada. Most of the traded fish were freshwater species (214 species, 68%), but marine species (69 species, 22%), and species from transitional environments (30 species, 10%) are also sold. The trade is dominated by fish that are native to tropical regions (88%), and by small-sized, relatively cheap species [e.g., *Betta splendens* (Siamese fighting fish)*, Carassius auratus* (goldfish), and *Poecilia reticulata* (guppy)]. Three alien monogenean parasites *Dactylogyrus lampam*, *Dactylogyrus tapienensis*, and *Dactylogyrus viticulus* were recorded on *Barbonymus schwanenfeldii* (tinfoil barb) imported into South Africa from Sri Lanka and Thailand as ornamental fish; with the fish imported from their native range (Thailand) having a greater number and diversity of parasites (Molokomme et al. 2023). Similarly, three of 18 species of freshwater ornamental Cichlidae imported from Indonesia, Sri Lanka, and Thailand, were found to be infected with the nematode *Capillaria pterophylli*, with a high prevalence (> 50%) in some species imported from Indonesia (Molokomme et al. 2025). This research confirmed the previous finding that the pet trade has a 'Moderate' *introduction pathway prominence*, and that the parasites on animals pathway has a 'Major' *introduction pathway prominence*.

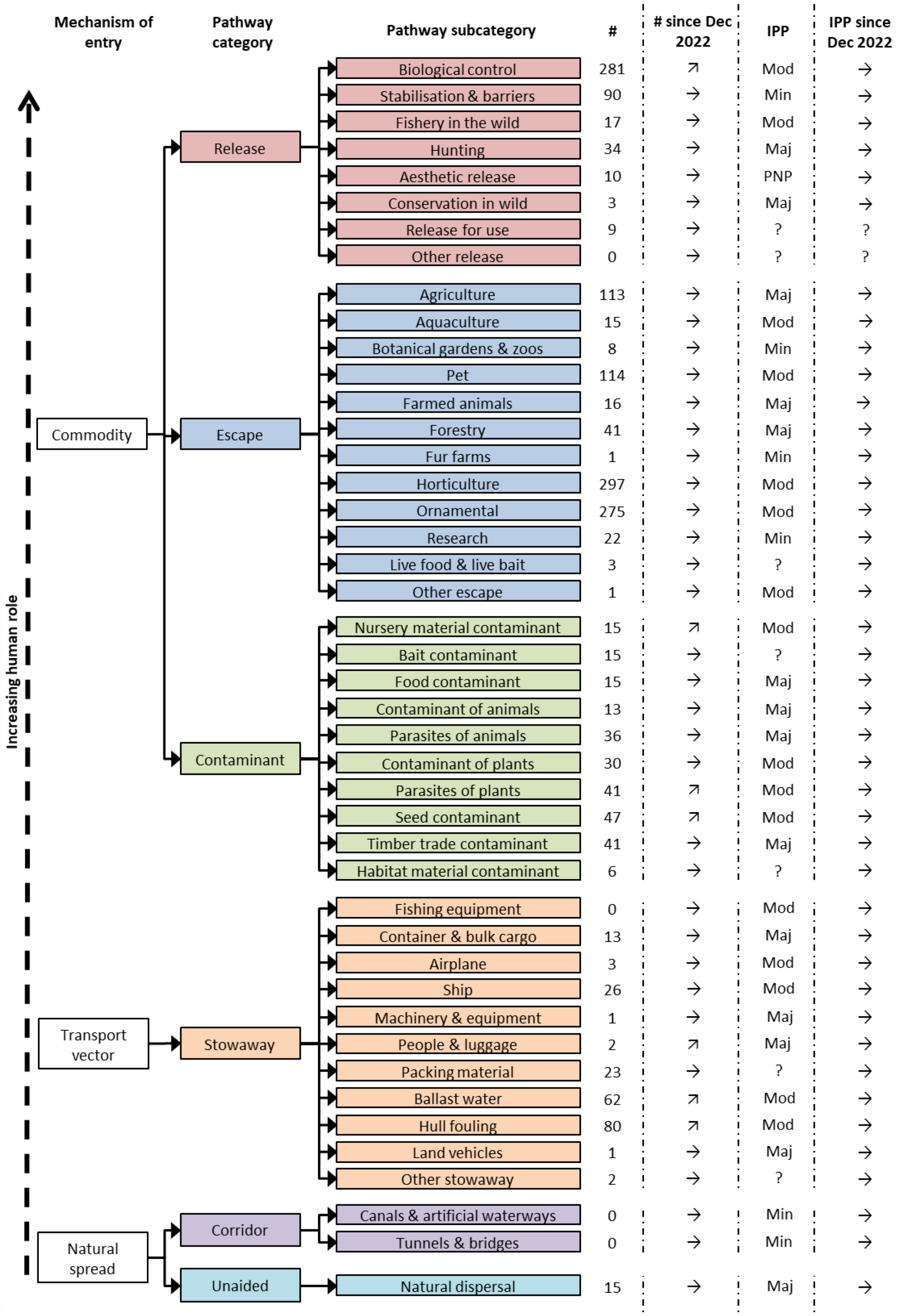


Figure 1.1. Current status of the introduction pathways and changes to the pathways that have been recorded during 2023–2025. #: number of taxa introduced; # since Dec 2022: change to the number of taxa introduced since December 2022 (↗ increase; → no change); IPP: introduction pathway prominence (Min: minor; Mod: moderate; Maj: major; PNP: pathway not present; ? not known); IPP since Dec 2022: change to introduction pathway prominence since December 2022 [↗ increase; ↘ decrease; → no change; ? not known; – not applicable (first estimate or new pathway)].

1.2. *Introduction rates*

Introduction rates considers the number of new alien taxa that have been introduced over all time to South Africa from other countries through each of the introduction pathways.

New alien species recorded in South Africa since December 2022 potentially entered the country through six introduction pathways. All were accidental introductions [nursery material contaminants, seed contaminants, as parasites of plants, as stowaways in the ballast water or on the hulls of ships, and potentially with people and their luggage (Figure 1.1)].

For most pathways there was relatively little change, with most introductions being plants introduced for ornamental/horticultural purposes (25% of taxa with known pathways) or agriculture (9%), contaminants or parasites of animals or plants and their products (16%), or stowaways on ships (9% - includes terrestrial species on the ship, as well as aquatic species in ballast water or on the hull) (Figure 1.1). However, directed research based on social media reports of pet bird escapes (Shivambu et al. 2024a); and on historical records of bark and ambrosia beetles (Nel et al. 2025) resulted in notable increases in the number of known introductions through the pet (now 9% of taxa with known pathways), timber trade contaminants (now 3%), and packing materials (now 2%) pathways. However, these were species that had been recorded before December 2022. For example, Nel et al. (2025) represented the first report of the bark beetle *Phloeosinus armatus* in the country, but the species was first recorded from samples taken in 2019. *P. armatus* originates from the eastern Mediterranean, has been introduced to several countries around the world, and is a pest on various species of Cupressus (Nel et al. 2025). Recent work has further highlighted the role the aquarium trade is playing in introducing alien species, with two new species, the freshwater planarian *Girardia sinensis* (first recorded in 2022; Trembath et al. 2023) and the freshwater snail *Sinotaia* cf. *quadrata* (first recorded in 2019; Miranda et al. 2022), likely being introduced as contaminants of the aquarium trade (though the snail was potentially introduced as a food source for humans). Plant parasites continue to be introduced with imported plants, with several new concerning species having been detected since the December 2022, for example, *Fusarium oxysporum* f.sp. *canariensis* (Fusarium wilt) and *Nalanthamala vermoesenii* (pink rot), which were both detected from samples taken in 2023 from ornamental palms at the V&A Waterfront in Cape Town (Ballocchi et al. 2024).

In terms of new regulated introductions (i.e., legal introductions), four new biological control agents have been released against invasive plants (Figure 1.1). See Figure 5.2 and Ivey et al. (2021) for details of how such introductions are regulated. Over the period 2023–2025 no other permits were granted to import any alien species that were not already legally in the country.

1.3. *Within-country pathway prominence*

Within-country pathway prominence considers the opportunities available for the movement of organisms within the country, and does not take into account how many dispersal events these opportunities result in. As in previous reports, data for within-country pathway prominence were not available for most pathways, and so the indicator could not be populated.

The data that were obtained showed that there has been a return to pre-pandemic levels of activity. For example, the number of scheduled aircraft arriving at South African airports from domestic destinations increased by 10% between the 2022/2023 and 2024/2025 financial years (Figure S1.21). Similarly, the number of passengers arriving at South African airports from domestic destinations increased by 22% between the 2022/2023 and 2024/2025 financial years (Figure S1.23). In both cases these numbers are comparable to those before the pandemic (within 10%).

Recent research has highlighted the role South Africa plays in breeding alien animals for the legal international pet trade and the risk that poses. Large numbers of many species (385 alien species and 114 native species) are being exported from South Africa to other countries, the majority of which are bred in captivity (Shivambu et al. 2024b). The vast majority are alien birds (peaked at ~ 500 000 individuals in 2021), but alien mammals (peaked at ~2500 individuals in ~2018) and reptiles (peaked at ~500 individuals in ~2022) are also exported (Shivambu et al. 2024b). Over the last two decades South Africa has built a huge aviculture operation through investment in captive facilities (Chan et al. 2021), and it was estimated in 2015 that there were over 1 600 breeding facilities in the country (Martin 2018). There are, therefore, large numbers of individuals of alien species being bred in captivity, and while many are exported, some are incorporated into the local pet trade – for example local breeders are the most common supplier of small alien mammals to South African pet shops (Shivambu et al. 2022). It is, therefore, not surprising that many of the highly exported species have escaped and established populations. For example, the alien lovebird *Agapornis personatus* (yellow-collared lovebird), the second most exported species (Shivambu et al. 2024b), has established several populations (Symes et al. 2021); and native-alien populations[18] of *A. roseicollis* (rosy-faced lovebird), the fifth most exported species, have been recorded (Symes et al. 2021; Nelufule et al. 2023).

There have been several studies on pathways that provide opportunities for the movement of alien plants within the country:

---

[18] alien populations of species that are native to another part of South Africa (Nelufule et al. 2022).

Hedges serve a range of functions in both urban and rural homesteads (e.g., firewood provisioning, signalling ownership and constraining livestock movement, windbreak, privacy, aesthetics) in the central Eastern Cape, and alien species are often used in homestead hedges, with 65% of hedges containing alien species, 24% of which were invasive (Sifanele and Shackleton 2025). Hedges were more common in urban areas (44% of homesteads) in comparison to rural areas (26%), and urban homesteads had a higher number of alien species in their hedges.

Institutions, such as universities, could be facilitating plant invasions. A study at Tshwane University of Technology recorded 94 alien plant species, including 43 that are listed in the A&IS regulations (Nelufule et al. 2024). Over half (51%) of these species were introduced for horticultural purposes, with many going on to form established populations. Almost half (46) of the recorded species were also found outside of the University grounds - indicating potential spill over or spread between the University and outside areas (Nelufule et al. 2024).

1.4. *Within-country dispersal rates*

Within-country dispersal rates considers the number of alien taxa that have dispersed within the country through the pathways of dispersal, including both taxa alien to the country, and those that have formed native-alien populations. As for previous reports, data for within-country dispersal have not been collated for taxa that are alien to the country (see Chapter 6). Work to update data on native-alien populations (see Nelufule et al. 2023) is ongoing (see Box 1.1 for details on a tool that will assist with this task). Therefore, the indicator cannot be populated. However, based on the reviewed literature, alien and native taxa are dispersing within the country through a wide range of pathways [at least 31 of the 44 pathways (70%)].

In some cases, human-mediated dispersal is likely driving movement:

Dematophora necatrix, a soilborne fungus that causes white root rot in a wide range of hosts, was recently recorded for the first time on native trees during tree health surveys in botanic gardens in Cape Town and Mbombela (Balocchi et al. 2025). While the fungus could have spread to these new locations in several ways, it most commonly spreads through contaminated soil and/or plants. Further spread into nearby natural populations of native species is a concern.

The marine bryozoan *Membranipora membranacea* was recently (2024) recorded for the first time in the country on Muizenberg beach, but was likely introduced to Table Bay Harbour, with its subsequent spread, against the prevailing currents, likely aided by vessels (Steyn and Robinson 2025).

The role vertebrates play in dispersing seeds of alien plants has been highlighted in several studies:

Troops of baboons in Hogsback forage more frequently in human-modified than natural habitats, and it is estimated that they transport seeds > 5 km during daily foraging events, with an estimated ~ 450 000 seeds, including those of alien species [e.g., *Acacia mearnsii* (black wattle), *Cotoneaster pannosus* (silver leaf cotoneaster), *Pinus patula* (patula pine), *Rubus cuneifolius* (American bramble), and *Solanum mauratianum* (bugweed)] being dispersed over seven months (Pamla et al. 2024). The baboon movement patterns suggest that alien plant seeds are being dispersed into the natural forest (Pamla et al. 2024).

Observations and video footage from the montane grasslands of South Africa has revealed that in these areas various animals serve as seed dispersers for *C. pannosus* (Moloi et al. 2024). Mammals which can have gut retention times that range from hours to weeks, may serve as long-distance dispersal vectors of *C. pannosus*, while birds likely serve as short-distance dispersal vectors - the maximum gut retention time for birds that eat the fruits was ~15 minutes [e.g., *Onychognathus morio* (red-winged starling)] (Moloi et al. 2024).

Another study in the grassland similarly showed that various vertebrates likely serve as dispersal vectors, with 100 000 seeds found in 11 295 faecal samples associated with 43 vertebrate species (Vukeya et al. 2025). Invaded sites had significantly higher seed rain than non-invaded sites, with the seeds found in the faecal samples from invaded sites being predominantly of alien species (Vukeya et al. 2025). At these sites birds were predicted to disperse seeds of *Pyracantha angustifolia* (yellow firethorn) and *Opuntia engelmannii* (small round-leaved prickly pear) more than 15 km, while mammals were predicted to disperse the seeds a maximum of 8.6 km, however, the study highlighted that both the quality and quantity of dispersal events needs to be considered, as while ingested *P. angustifolia* seeds were viable (47% viability), *Opuntia engelmannii* seeds were rarely (5.4% viability) (Vukeya et al. 2025).

Many alien species are moving within the country through a mix of natural and human-mediated dispersal:

The marine bryozoan *Amathia verticillata* (spaghetti bryozoan), was likely introduced to Saldanha Bay via biofouling and then spread via fragmentation, to where it was first recorded on a jetty in the Langebaan Lagoon Marine Protected Area within the West Coast National Park (Ackland et al. 2025).

Invasive plant richness recorded from two powerline servitudes in Limpopo was greatest closer to human settlements, with the servitudes possibly acting to either facilitate the spread or establishment of invasive species (Dalu et al. 2023).

A study of trees on the sidewalks and in the front gardens of houses in the town Prince Albert showed that gardeners showed a preference for planting alien species (65% of planted species were aliens, and 63% of planted individuals were aliens) (Milton and Dean 2025). However, most trees were not planted but were self-seeded, with more frequently planted species more likely to self-seed. However, seedling distribution for fleshy fruited trees was also partly explained by bird dispersal.

Long-distance, within-country dispersal events aided by humans (e.g., as a contaminant on transported nursery plants, and as a stowaway on boats), as well as short-distance natural dispersal events likely facilitated the rapid spread and high connectivity of *Harmonia axyridis* (the Harlequin ladybird) populations, which shows little genetic structure across the country (Collop et al. 2024).

Although *Ligustrum* species (privits) are not common in the formal plant trade, they may be informally traded and are commonly found in gardens, which serve as sources of propagules that are being dispersed by water bodies (e.g., rivers) and animals (Shepard et al. 2025).

Similarly, alongside established populations of *Cortederia* species (pampass grass), cultivated populations, and formally and informally traded inflorescence are likely contributing to the spread of the two *Cortederia* species (*C. selloana* and *C. jubata*) in the country (Mbele et al. 2025). Until recently, only sterile cultivars of *Cortaderia* were permitted to be sold in nurseries, yet seeds from cultivated populations and formally traded inflorescence had germination rates of 69% and 15%, respectively (Mbele et al. 2025). Seeds from informally traded inflorescence, which were likely collected from established populations (germination rate of 70%), had germination rates of 32% (Mbele et al. 2025).

1.5. High-level indicator: 1. *Rate of unregulated introduction of new species*

The high-level indicator *rate of unregulated introduction of new species* estimates the total number of new alien taxa introduced accidentally or illegally each year.

Over the last decade (2016-2025), 40 new alien species, that were either illegally or accidentally introduced (i.e., unregulated introductions), have been recorded—an average of four new alien species per year (Figure 1.2). Although this is slightly less than the number recorded between 2013-2022 (43 new alien species – an average of 4.3 per year), this number is likely an underestimate and will increase due to delays in reporting (Figure 1.2).

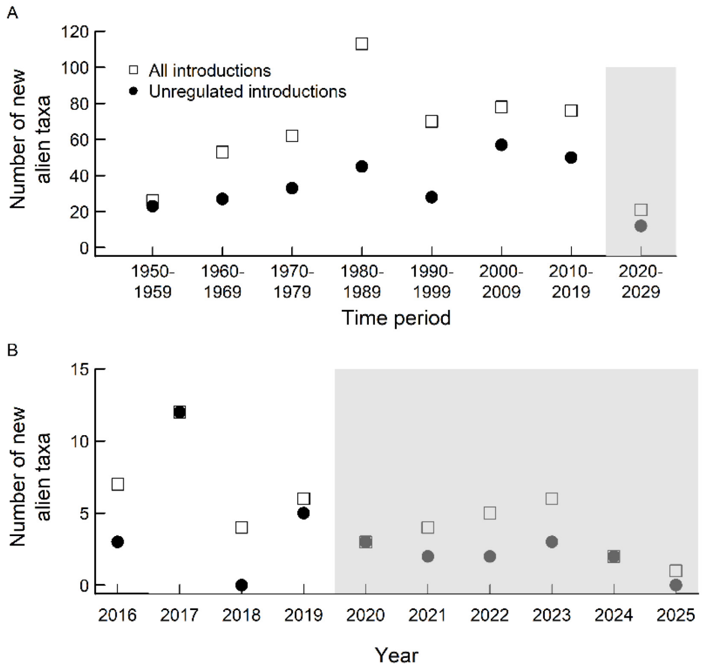


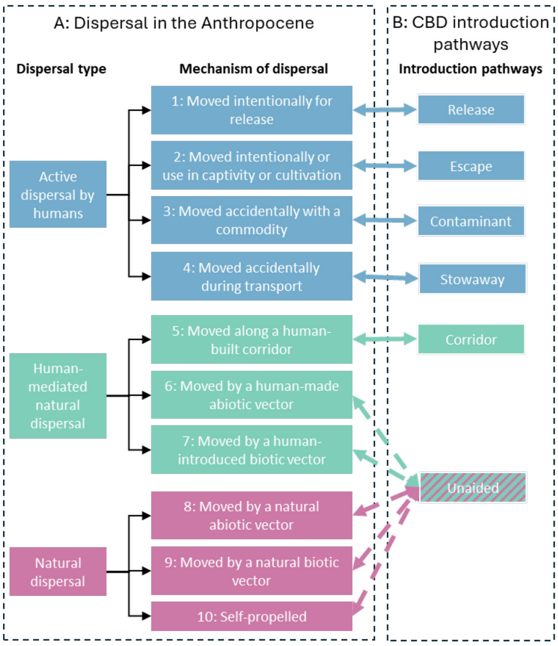
Figure 1.2. Number of new alien taxa recorded in South Africa over time: A, over the last eight decades; B, during the last decade. These are alien taxa not previously found or known to be present. The low number of recent unregulated introductions (shaded in grey) likely reflects delays in detecting and reporting alien taxa. Based on experiences from the past three reporting cycles, the number of recent unregulated introductions are likely severely under-reported, and the number reported will increase as new data become available (cf. Table S1.5). These data provide the basis for scoring *Rate of unregulated introduction of new species* and part of reporting on Target 6 of the GBF.

1.6. Trends in pathways since 2014

[work in progress]

Box 1.1 A simple, global scheme for classifying the movement of organisms in the Anthropocene

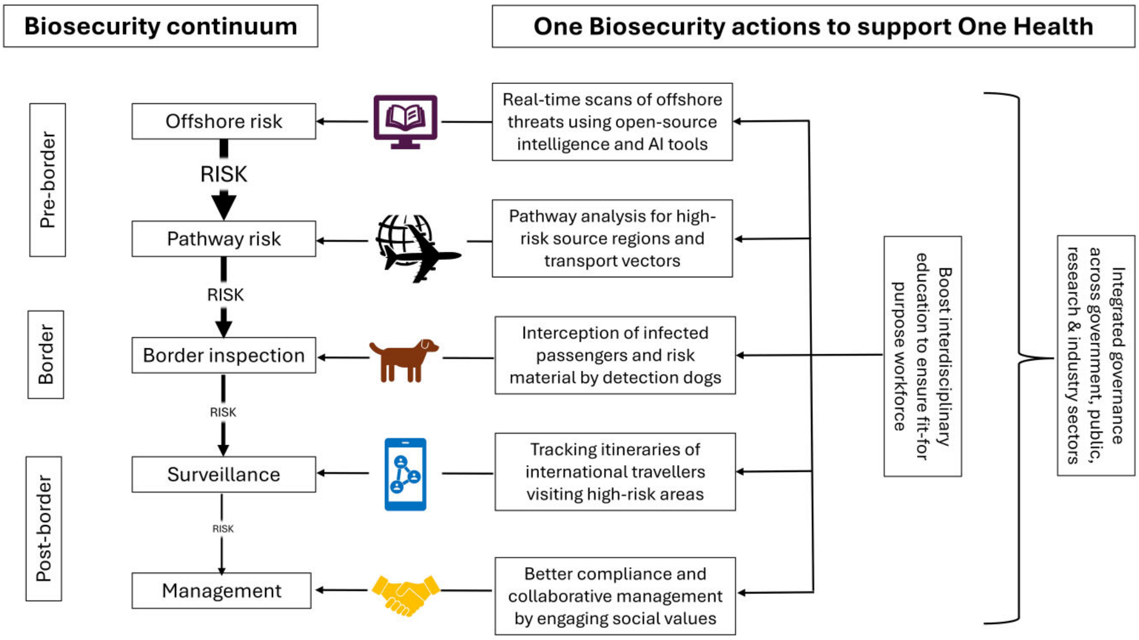
To achieve target 6 of the Kunming-Montreal Global Biodiversity Framework (GBF) and reduce introductions, biosecurity and surveillance to manage pathways of introduction and within-country dispersal need to be implemented (IPBES 2023). However, we have limited understanding of how alien species are moving around the country (cf. Sections 1.3, 1.4) and thus such actions within the country cannot be directed to where they are needed most. Although the introduction pathway classification framework of the CBD (CBD 2014) has guided the monitoring and reporting of introduction pathways (see Figure 1.1), the relevance of the framework for within-country dispersal is limited as it focuses on introductions across political or biogeographical boundaries, and does not adequately capture natural dispersal (Faulkner et al. 2020). To address this, a simple, global, policy-relevant scheme for classifying the movement of organisms in the Anthropocene was proposed (Faulkner et al. 2024). The scheme extends the introduction pathway framework, and classifies dispersal into ten categories associated with active dispersal by humans, human-mediated natural dispersal, and natural dispersal. It is largely interoperable with the introduction pathway framework, but splits natural dispersal into several categories (Box Figure 1.1). Each category is linked to high-level management actions (including potential biosecurity interventions) and responsible parties. Consequently, the scheme will assist with the monitoring, reporting, and strategic management of alien species movements irrespective of whether the focus is on introductions into or within political or biogeographical boundaries



Box Figure 1.1 The scheme for classifying dispersal in the Anthropocene (A) expands the widely used introduction pathway classification framework (B), so that it addresses all types of dispersal that might need management or regulation (specifically, the introduction of alien species to a region, the movement of alien species within a region, and the movement of native species within a region).

Box 1.2 One Health and One Biosecurity

Animal, environmental, human, and plant health are interconnected, and, in many cases, attempts to manage one aspect without considering the other aspects are ineffective. To address this, the concept of One Health has been developed as a partnership between the Food and Agriculture Organization of the United Nations (FAO), United Nations Environment Programme (UNEP), the World Health Organization (WHO), and the World Organisation for Animal Health (FAO, UNEP, WHO, and WOAH, 2022). However, despite the 1st World One Health Congress taking place in 2011, the environment is still poorly represented, and there are very few studies that explicitly link the concept of One Health to the concept of biosecurity (Hulme 2025). Hulme (2020), recognising that addressing biological invasions is cross-cutting and measures to address them require integrated governance (IPBES 2023), defined the concept of One Biosecurity as an "*an interdisciplinary approach to biosecurity policy and research that builds on the interconnections between human, animal, plant, and ecosystem health to effectively prevent and mitigate the impacts of invasive alien species*". Environmental agencies work to prevent the introduction of alien taxa that pose a threat to nature; agricultural agencies work to prevent the introduction of agricultural pests; and health agencies work to prevent the introduction of pathogens and their vectors (including emerging infectious diseases). There is a need for such efforts to be integrated as many of the methods, approaches, and goals are the same (Ogden et al. 2019; Box Figure 1.2). The integration of biological invasions into One Health thinking in South Africa is still very much in its infancy, though opportunities exist with the development of the national strategy on biological invasions, via structures like the Border Management Authority, and through more collaboration with neighbouring countries on shared threats. Better integration will be complicated but is essential if interventions are to be effective.



1370

1371 **Box Figure 1.2.** Activities to address biological invasions that would benefit from a One Biosecurity approach.
1372 There is an opportunity in South Africa (and southern Africa and Africa more generally) to map this onto
1373 current strategies and action plans to identify areas where synergies are possible. Reproduced from Figure 5,
1374 Hulme et al. (2025).

2. Species

Lead authors: Tsungai A. Zengeya, Masingitla P. Mtileni, John R. Wilson

Contributing authors: tbc

Findings for Species

- The number and status of alien species in South Africa was recently updated. The list now includes over 6000 taxa, of which over 3500 are present outside of captivity or cultivation and 719 taxa are invasive.
- Only a few alien species are widespread, the majority are still localised and found in low numbers. However, the recorded extent of most species has markedly increased and will continue to increase unless effective control is put in place. In particular, data on the abundance of selected invasive plant taxa in water catchments and terrestrial biomes from the National Invasive Alien Plant Survey (2008–2023) indicate most taxa have increased in cover despite mechanical and chemical control efforts, but there were decreases in cover for taxa under biological control.
- Recent national impact assessments (conducted in line with the IUCN's EICAT framework) have found several species to cause 'Major' or 'Massive' impacts. Complementary assessments using risk analyses and findings from the IPBES IAS Assessment confirm that these species cause widespread harm across multiple sectors of society.

Gaps for Species

- Data on the distribution and abundance of alien species need to be collected, collated, and integrated into national and global databases to facilitate the planning of interventions.
- Impact assessments have been conducted for only a few alien taxa in South Africa. The systematic quantification of the impacts of biological invasions and the collation of such information in formal impact assessments would: facilitate the prioritisation of interventions targeting particular species and particular sites; provide the justification for government investment to control biological invasions; and provide important background to communicate the issue to society.

Invasion-specific outcomes

2. Number of invasive species that have 'Major' impacts

2.1. Number and status of alien species

2.2. Extent of alien species

2.3. Abundance of alien species

2.4. Impact of alien species

2.1. *Number and status of alien species*

The list of alien taxa for South Africa was updated in 2025 (Appendix 6; Zengeya et al. in press) and now includes over 6000 taxa, of which there is evidence that 3825 taxa are present, the presence of 1642 taxa is doubtful[19] and 714 taxa are recorded as absent[20] (Table 2.1, Section S2.1). Over half of the taxa that are present are plants, confirming the assertion that South Africa is a hotspot for plant invasions. Doubtful taxa were mostly plants (presumed to be in cultivation, but there are no recent records). Only about a third of taxa have been assessed for their introduction and establishment status in South Africa as of December 2022, 719 of those taxa are invasive, 120 taxa are known to be established but not invasive, and 329 taxa are present but not established (Figure 2.1).

Table 2.1. The number and occurrence status of alien taxa in South Africa as of September 2025. For more details, including taxa assessed, scored as absent, and their regulatory status, see Table S2.1 and Appendix 6.

Taxa	Doubtful	Confirmed as present
Animals	343	1387
Bacteria	0	4
Chromista	0	13
Fungi	6	105
Plants	1293	2315
Protozoa	0	1
Total	**1642**	**3825**

[19] Taxa were assessed as doubtful if there is some evidence of the taxa having been present in South Africa, but there is doubt over the evidence or whether it is still present as of December 2025, including taxonomic or geographic imprecision in the records. A protocol to classify presence in cases where there is uncertainty has been developed, and will be implemented more in future (Matthys et al. 2026)

[20] Taxa that were assessed as absent were either biocontrol agents that were released to control invasive plants but that did not establish, taxa listed as prohibited in at least one version of NEM:BA A&IS Lists, and or taxa included in previous status reports but there is no evidence that they are present

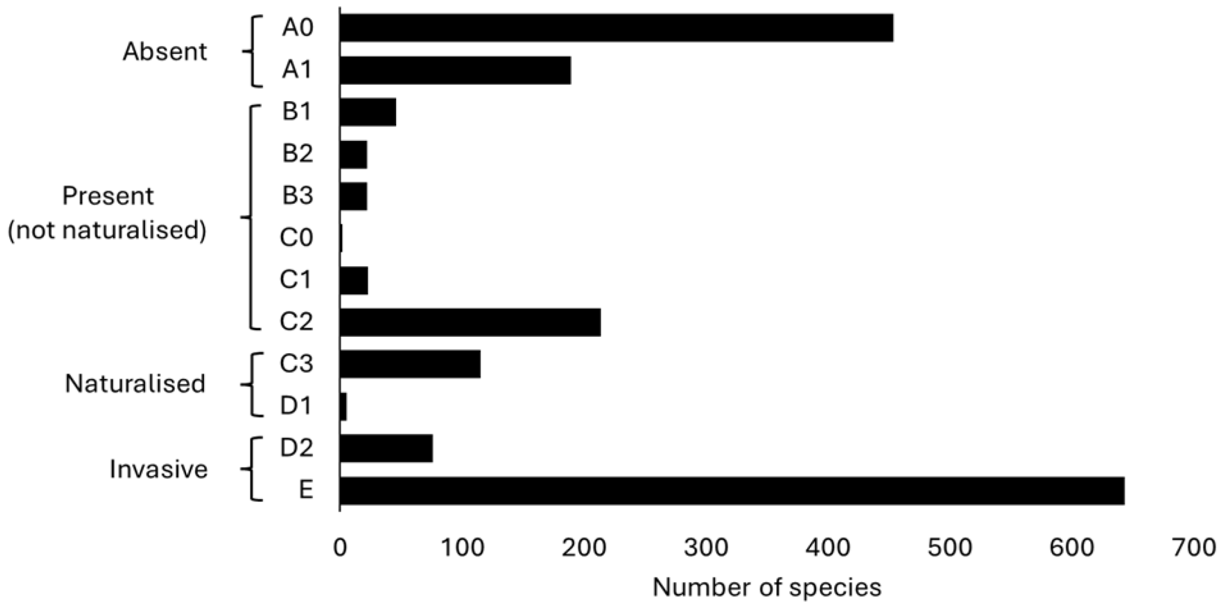


Figure 2.1. The introduction and establishment status of alien species in South Africa as of December 2022 as per the Unified Framework for Biological Invasions (Blackburn et al. 2011). Absent (A0–A1)—taxa that have never been introduced beyond the limits of their native range to [a part of] South Africa (A0) or were introduced but no longer present (A1); Present (not established) (B1–C2)—includes a range of taxa from those in quarantine to those that are reproducing outside of captivity or cultivation but where there is no clear evidence of having formed self-sustaining populations; Established (C3–D1)—taxa where there is establishment, and possibly spread, but there is no clear evidence of forming self-sustaining populations at a significant distance from point of introduction; and Invasive (D2–E)—taxa with populations that are self-sustaining at a significant distance from the point of introduction. Selected species that are not present in South Africa (A0 and A1) are included in the list and report for various specific reasons, e.g., they were included on the prohibited lists of versions of the A&IS Regulations (cf. Section S2.1).

The process to create and curate the list of alien taxa in South Africa has improved over time and was recently reviewed by Zengeya et al. (2025). Key developments include improvements in how data were presented, how changes were tracked, and the degree to which the information was consistent with international best practice. The development of documented and repeatable workflows ensured clarity on why a species was included on the list and facilitated reviews and updates. The perspective has also provided recommendations for those developing national lists of alien species (See Table S2.3 for how these have been addressed in this report; and Box 2.1 for related recent papers). National lists of alien species are never complete or perfect. Lists are dynamic and need constant updating as new alien species are discovered, populations die out or are extirpated, and as new information becomes available. Therefore, this list, like all lists of alien taxa, represents a snapshot of the situation. The presence of many alien taxa needs to be confirmed and documented; many data sources still need to be incorporated into the list; and it is likely that many alien taxa have not, as yet, been recorded (see Section S2.1 for further details on progress made to update the list).

As examples, recent discoveries of alien marine taxa (Ackland et al. 2025; Steyn and Robinson 2025), many alien taxa in captivity or cultivation (Glen 2002, Hoy et al. 2021), medicinal plant trade (e.g., Williams et al. 2021; Williams et al. 2022), aquarium trade (e.g., Vezi et al. 2024) still need to be added. Similarly, many groups and habitats have been under-sampled. For example, information on most microorganisms is either not incorporated, is hard to incorporate as issues of nativity are unresolved, or there simply has been no sampling (e.g., few ecto-mycorrhizal fungi have been incorporated to date, despite their large conspicuous fruiting bodies; see examples in Goldman and Gryzenhout, 2019). Thus, the list provides an underestimate of the number of alien taxa in the country, and this number will increase as new and historical data sources are verified and incorporated, and as new alien taxa are recorded and reported. These limitations mean that the list is not yet a complete baseline of the knowledge of which alien taxa are present in South Africa. As such, differences between this list and the lists from previous reports (e.g., addition or removal of a taxon) need to be carefully interrogated, as they do not necessarily mean that there has been a true change (sensu Zengeya et al. 2025).

2.2. *Extent of alien species*

2.2.1. Number of broad-scale regions occupied per species

Occurrence data were updated based on data published by the Global Biodiversity Information Facility (GBIF; data accessed [11 September 2025]) for 3072 taxa. Similar to previous reports, many taxa are localised invaders, but a few taxa are widespread (Figures 2.2, 2.3). The process of mobilising and analysing spatial data has been improved by adopting practices from other initiatives on compiling lists such as the Biodiversity Building Blocks for Policy (B-Cubed) project (Groom et al. 2025, https://b-cubed.eu/). The B-Cubed project has developed pipelines to improve integration of biodiversity data into data cubes that can be used for models and indicators of biodiversity monitoring. These data cubes and workflows have assisted with the automation and standardisation of the process and how the status reports are communicated (see Box 2.2).

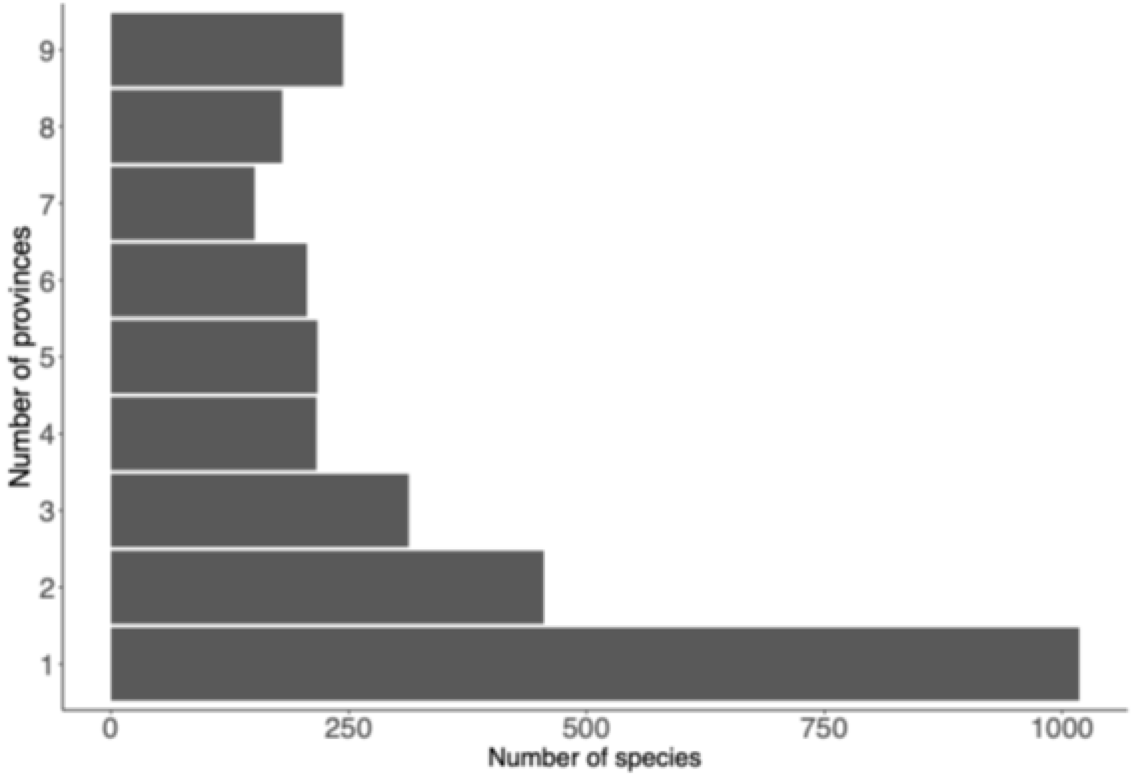


Figure 2.2. The extent of alien taxa at the provincial scale as of September 2025. This is based on occurrence records from Global Biodiversity Information Facility (GBIF) and Southern African Plant Invaders Atlas (SAPIA) for mainland South Africa.

2.2.2. Number of quarter degree grid cells (QDGCs) occupied per species

Most alien taxa have relatively restricted distributions (fungi and mammals), but some taxa are widespread [e.g., birds and plants occupy more than 500 out of about 2000 quarter degree grid cells (QDGCs) covering South Africa; Figure 2.3]. Many taxa showed an increase in extent since 2022 (Figure 2.4; and Table S2.4 for details of those plant taxa that have shown the greatest increases in recorded ranges). As noted in previous reports, the integration of GBIF with widely used citizen science platforms such as iNaturalist has improved the reporting of occurrence data for alien taxa. For example, iNaturalist contributed over 90% of the GBIF occurrence records of alien fungi taxa in South Africa (Fig. 2.3).

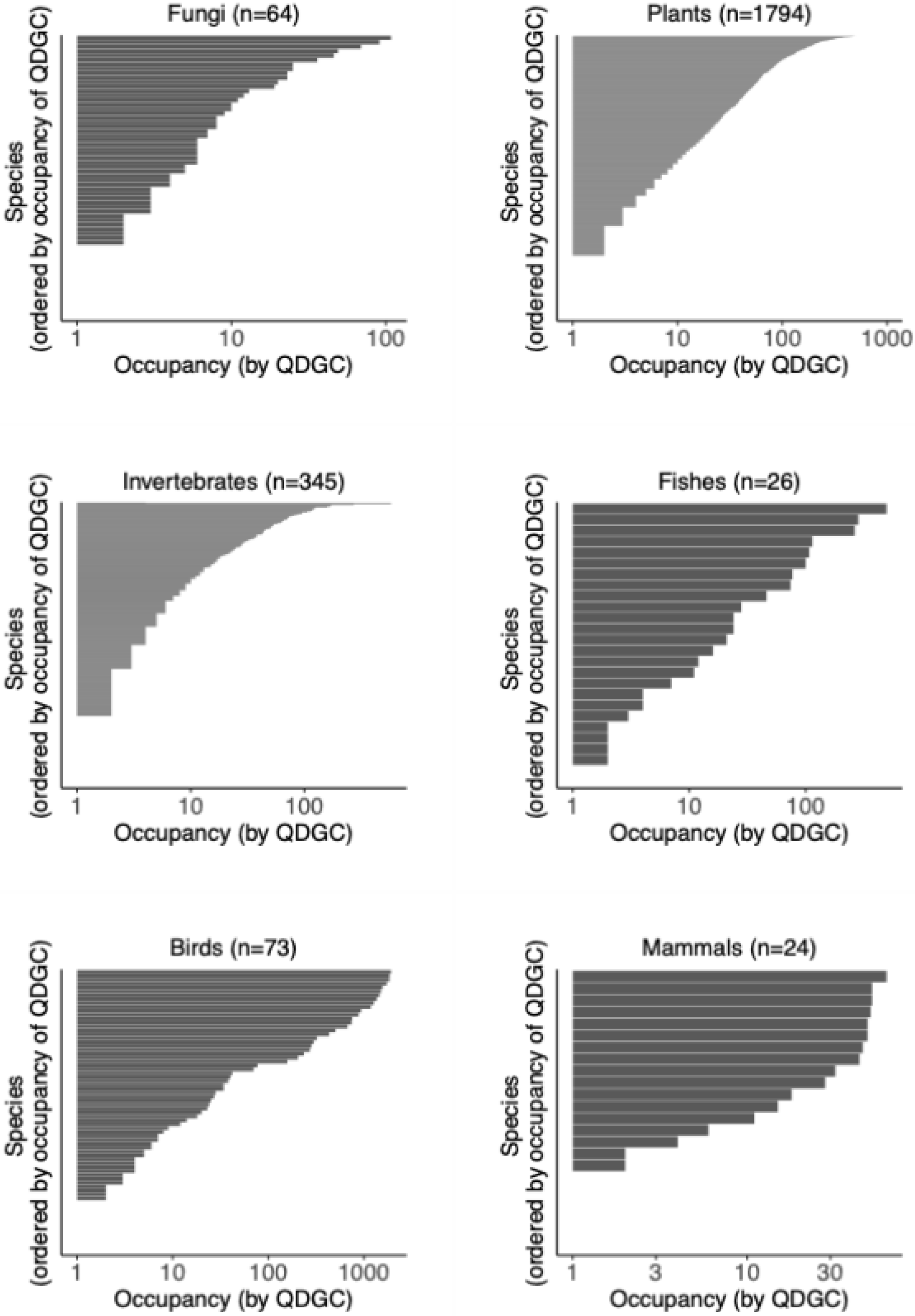


Figure 2.3. The distribution of alien taxa in quarter degree grid cells (QDGCs) in South Africa.

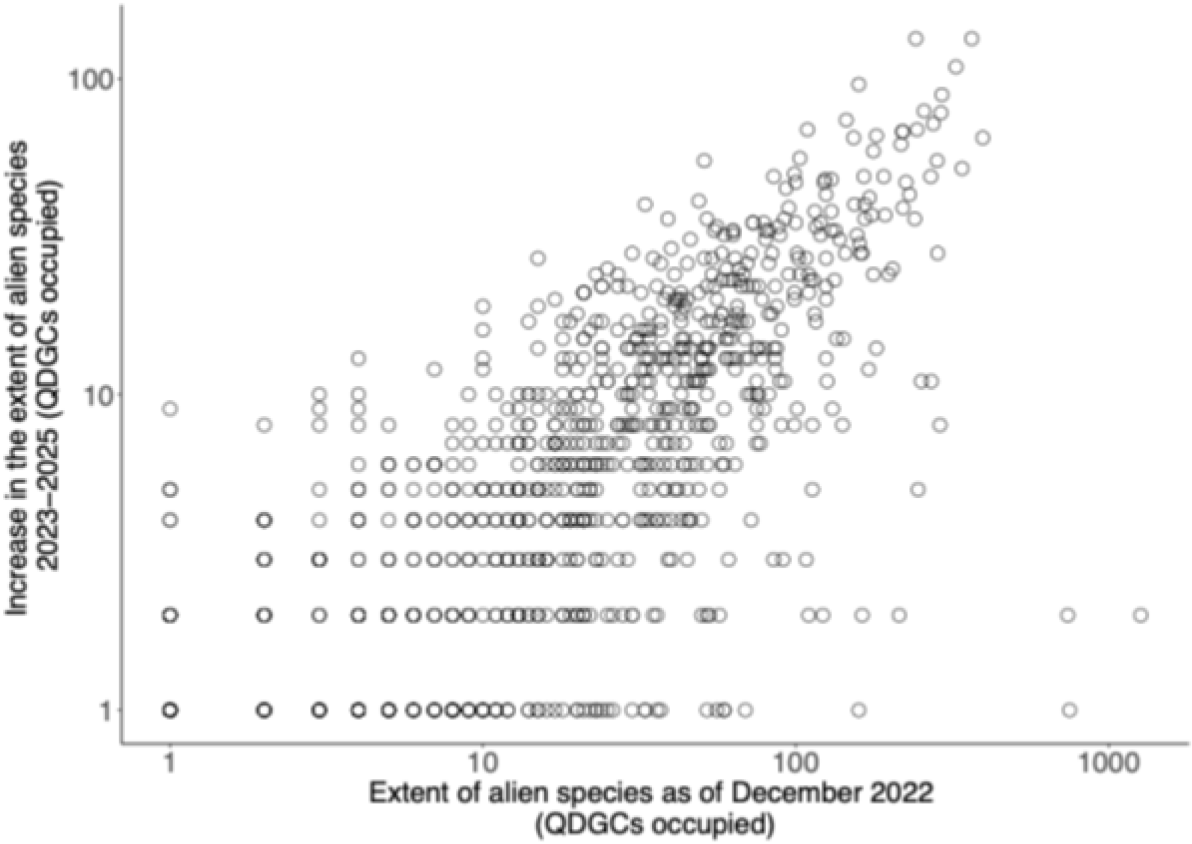


Figure 2.4. The extent of alien taxa in South Africa (December 2022 vs September 2025). The values shown are the number of quarter degree grid cells (QDGCs) where taxa have been historically recorded. The possibility that taxa are no longer present in a QDGC is not assessed, as such, taxa cannot have a decreased extent. Data are from Southern African Plant Invaders Atlas (SAPIA) (accessed 17 March 2020) and Global Biodiversity Information Facility (GBIF) [accessed 11 September 2025].

2.3. *Abundance of alien species*

In previous reports, estimates of the abundance of alien species were based on two sources of data on terrestrial plants – a 1998 report to the Water Research Commission (Versfeld et al. 1998) and the National Invasive Alien Plant Survey (Kotzé et al. 2010). This situation has not changed. There have been some recent developments, for example, a recent analysis of the National Invasive Alien Plant Survey has shown that the level of invasions is increasing in important water catchments, and in most terrestrial biomes in South Africa (Kotzé et al. 2025). The study was initiated in 2007 and included 14 dominant invasive plant taxa. The survey was completed in 2008 and repeated between 2016 and 2023. Plants on average increased in extent by 10.6% between the two surveys leading to an estimated 1.6% of the country being invaded by the end of the second survey (i.e., 2023). Trees in the genera *Acacia*, *Eucalyptus*, *Pinus*, and *Neltuma* (formerly *Prosopis*) accounted for almost three quarters (72.4%) of the cover (Table 2.2). Most of the taxa increased in cover between the two surveys, and decreases in cover were only recorded at a national scale for taxa that had been subjected to biological control, while taxa that did not have biological control all continued to increase in cover despite mechanical and chemical control efforts. The highest declines in cover were in the Cactaceae species (−29%), followed by *Acacia saligna* (−18%) and *Hakea* species (−16%). Selected wattle species (*Acacia* species), *Eucalyptus*, and *Neltuma* species increased by 22, 18, and 10% respectively between the two surveys. Another study using remote sensing in selected river catchments (Luvuhu, Sabie-Crocodile, Tugela, and uMzimvubu) found that about 10% of the catchment areas were covered in alien trees either in the form of plantation forestry or invasive stands (Rebelo et al. 2025).

Table 2.2. Changes in the extent of invasion (condensed ha) by 14 alien plant taxa at a national scale in South Africa from two successive surveys done in 2008 and 2023 respectively. A condensed hector (mean % cover × area occupied) is the equivalent area occupied at a canopy cover of 100% (i.e., 50% cover on 10 ha = 5 condensed ha).

Taxa	First survey (2008)	Second survey (2023)	% Change
Acacia cyclops	65421	64422	-1,5
Acacia saligna	54535	44454	-18,5
Acacia species	503278	527904	4,9
Arundo donax	10124	10958	8,2
Cactaceae	59121	42050	-28,9
Chromolaena odorata	74833	77133	3,1
Eucalyptus species	243407	285569	17,3
Hakea species	22047	18601	-15,6
Lantana camara	37593	39818	5,9
Melia azederach	27101	28450	5,0
Neltuma (= *Prosopis*) species	94552	106772	12,9
Pinus species	96847	98974	2,2
Populus species	43598	45401	4,1
Solanum mauritianum	43221	47466	9,8

2.4. *Impact of alien species*

Previous reports have highlighted that biological invasion are a major threat to South Africa's biodiversity, economy, and sustainable development. However, they have also highlighted that there are few studies that formally document impacts (see Section S2.5; van Wilgen et al. 2022a; Zengeya and Wilson 2023). This situation has not changed. National-level EICAT assessments have been completed for 36 species (Table 2.2), three taxa were recorded as having had 'Moderate' impacts, 18 'Major' impacts, and *Oreochromis niloticus* has had a 'Massive' impact. The seemingly high proportion of taxa with harmful impacts is, however, an artefact as taxa known to cause impact were prioritised for assessment. As efforts to collate information on the impacts of alien species using standardised protocols increase, a more complete picture will emerge. Few national-level SEICAT assessments have been done in South Africa (see Section S2.5). [to be updated to reflect studies done as of December 2025]

Up to December 2025, 170 taxa had risk analyses completed using the Risk Analysis Framework for Alien Taxa (RAAT) framework, including 148 of the 560 taxa listed under the A&IS Regulations (Table S4.1). The RAAT framework evaluates environmental and non-environmental impacts of alien species using methods that are similar to EICAT and SEICAT assessments. However, while the risk analyses provide indications of potential impacts, they are not as comprehensive as a full EICAT and SEICAT assessments and are regarded with low confidence. 48 of these taxa had environmental impacts that have been recorded in South Africa, of which 30 taxa were estimated to have 'Minimal Concern'. 'Minor' or 'Moderate' impacts, 15 'Major' and three taxa (*Acacia cyclops*, *Mytilus gallopronvincialis*, *Oreochromis niloticus*) have 'Massive' impacts. Several native plant taxa have been displaced or become locally extinct as result of competition from *Acacia cyclops* (e.g., Le Maitre et al. 2011) and *A. cyclops* has caused chemical, physical, and structural changes to ecosystems that have resulted in the local extinction of at least one native taxon (Milton 1981; Milton and Siegfried 1981; van Wilgen and Richardson 1985). *Mytilus galloprovincialis* has outcompeted and displaced native benthic communities in intertidal zones (Sadchatheeswaran et al. 2015, 2018), *Oreochromis niloticus* hybridises and supplants native *Oreochromis* species (D'Amato et al. 2007; Firmat et al. 2013).

35 species that had completed risk analyses had socio-economic impacts recorded in South Africa. 28 of these taxa were estimated to have 'Minimal to Moderate' impacts, and seven taxa (*Bemisia tabaci*, *Cenchrus setaceum*, *Cinara cupressi*, *Nerium oleander*, *Pathenium lysterophorus*, *Psittacula krameria*) have 'Major' impacts. For example, fountain grass *Cenchrus setaceum* causes damage to infrastructure such as roads, railways and waterways (Milton et al. 1998, Rahlao et al. 2010) and the Rose-ringed parakeet *Psittacula krameria* is considered a serious agricultural pest (Hart and Downs 2014).

Table 2.2. The number of taxa that have impact assessments for South Africa in terms of the Environmental Impact Classification for Alien Taxa (EICAT) as of September 2023 (see Table S2.5 for more details). Only four taxa (all trees and shrubs), have impact assessments for South Africa in terms of the Socio-Economic Classification of Alien Taxa Scheme (SEICAT). [Note: to be updated to studies done as of December 2025]

Group	Data Deficient	Minimal Concern	Minor	Moderate	Major	Massive	Total
Grasses, annuals, and vines	7	0	2	2	2	0	**13**
Trees and shrubs	0	1	0	1	11	0	**13**
Freshwater fishes	0	0	0	0	4	1	**5**
Freshwater invertebrates	4	0	0	0	0	0	**4**
Terrestrial invertebrates	0	0	0	0	1	0	**2**
Total	**11**	**1**	**2**	**3**	**18**	**1**	**36**

83 taxa had environmental impacts that have been recorded in global introduction range but not in South Africa. 62 of these taxa were estimated to have 'Minimal Concern'. 'Minor' or 'Moderate' impacts, 19 'Major' and two (*Rattus rattus*, *Robina pseudoacacia*) have 'Massive' impacts. Eighty-five

taxa had socio-economic impacts that have been recorded in their global introduction range but not in South Africa. Seventy-seven of these taxa were estimated to have 'Minimal Concern'. 'Minor' or 'Moderate' impacts and seven had 'Major' impacts. Two taxa had 'Massive' impacts—*Vespula germanica* (the German wasp) that impacts human health (Kerr and Sharp 2008) and *Chondrilla juncea* (skeleton weed) that is known to affect crop production (Panetta and Dodd 1987).

Biological invasions were also highlighted as a major global threat to biodiversity and sustainable development by the IPBES IAS Assessment (IPBES 2023). A dataset, Global Impacts Dataset of Invasive Alien Species (GIDIAS), was created to document the positive, negative, and neutral impacts of invasive species on nature, nature's contributions to people, and good quality of life (Bacher et al. 2023). The GIDIAS dataset has records of impacts assessments for 102 invasive species on nature for South Africa. 45 of these taxa have either led to decreased performance of individuals of native species and or reduced population sizes of native species, while one taxon (*Micropterus dolomieu*) has led to the local or global extinction of native species (Woodford et al. 2005). Only a few taxa have impact assessments for South Africa in terms of nature's contributions to people (8 taxa) and good quality of life (4 taxa) (See Table S2.6 for more details).

A few studies have been done on the impact of alien species in the past three years (since 2022). [to be updated]

2.5. High level indicator: 2. *Number of species that have 'Major' impacts*

Impact assessments for South Africa (based on the IUCN's EICAT framework) have found that 19 species have caused 'Major' or 'Massive' impacts. Complementary assessments using risk analyses and findings from the IPBES IAS Assessment confirm that these species cause widespread harm across multiple sectors of society. However, as only few taxa have been formally assessed, the need for more studies and assessments on the impact of invasive species has been highlighted as a research priority for South Africa (Chapter 6).

The number of invasives that have 'Major' impacts will increase as more impact assessments are conducted. The formal assessment of the impact of alien species provides the rationale for regulation and management, can improve compliance and implementation of intervention measures, and assist to resolve conflicts. However, impact assessments are hampered by a lack of reliable data for most species. If this situation persists, regulations will continue to be vulnerable to legal challenges.

2.6. Trends in number and status of species since 2014

[Note: to be completed in the final report]

Box 2.1 Lists of alien taxa in the Global South—three joint journal special issues

Lists of alien taxa are essential for linking evidence to action (Wilson et al. in review). However, the recent IPBES IAS Assessment identified significant gaps in the completeness and availability of lists of alien taxa in the Global South (IPBES 2023). To address this, and as part of the need to develop processes for the lists of taxa in South Africa, three joint special issues were developed and published early in 2026. The special issues were based on data collected from over 40 countries and consist of 11 papers in African Biodiversity & Conservation www.abcjournal.org (addressing African issues), 6 papers in Bioinvasiones http://bioinvasiones.org/ (addressing issues in Latin America and the Caribbean), and 12 papers in NeoBiota https://neobiota.pensoft.net/topical_collection/270/ (addressing issue of broader interest or from other regions). The papers compare lists of invasive taxa from different countries; present lists for particular countries, types of taxa, and environments (including social wasps, horticulture, marine ecosystems, and protected areas); and develop workflows and protocols to assist with the creation of lists (e.g., guidance as to how to incorporate information from citizen science and molecular databases, and to address uncertainties). Those relevant to South Africa are listed in Box Table 2.1.

Box Table 2.1 Papers published in the special issues 'Developing lists of alien taxa in the Global South' that address invasions in South Africa, a further four papers look at invasions in continental southern Africa. For the full list of paper published see https://docs.google.com/spreadsheets/d/1XwqEoKNNKarwmUVrhL6R6ffTtPmNLf_P42vmi71BR7Y/.

Reference	**Title**	**How it was or will be used in the report**
Faulkner (in press)	An automated workflow to standardise taxon names for South African alien species lists	The workflow was used to standardise names for South Africa's list of alien taxa (cf. Appendices 2 and 6).
Fernández Winzer et al. (2025a)	From detection to action—a proposed workflow to ensure first reports of alien species from molecular analyses are acted upon	The workflow identified several taxa that were thought to be absent from South Africa, but appear to be present. The intention is for the workflow to be incorporated into the workflow: *Tracking data sources and adding data as published*
Gildenhuys et al. (2025)	Deriving inventories of non-native plant species from iNaturalist: Insights from urban centres of the Western Cape, South Africa	The workflow provides a method to develop inventories of alien plants from urban centres; it will in future reports be used to assist with estimating '3.1 *Alien species richness*'
Matthys et al. (2025)	Argument maps can support decisions to declare the presence of alien species: South Africa as a case study	The intention is to incorporate argument maps into the workflow '*Introduction status and degreeOfEstablishment*' to address cases where presence in South Africa is uncertain (specifically the fields *occurrenceStatus* and *occurrenceStatusConfidence*).
Nelufule et al. (in press)	The role of citizen scientists in managing invasive alien plant species and aiding early detection in Kloofendal nature reserve, Johannesburg, South Africa	An example of how citizen science groups can be used to compile lists of alien species of alien plants (cf. Chapter 5); and how these lists can be used to support appropriate management interventions (cf. Chapter 4)

Reference	Title	How it was or will be used in the report
Nelufule et al. (in press)	A comprehensive checklist of alien and invasive plant species within protected areas of the City of Johannesburg, Gauteng province, South Africa	Provides data to assist with estimating '3.1 *Alien species richness*', and baselines with which to monitor spread.
Nxele (in press)	Bridging Indigenous Knowledge Systems and Western ecological science approaches through language: the role of language in ecosystem restoration and invasive alien species management	Provides an example of methods to encourage community-based management of invasions (cf. Chapter 5).
Potgieter et al. (2025)	An evidence-based protocol for developing lists for tree planting	An example of a tool to produce a 'safe' list (i.e., what can be planted rather than what is prohibited from being planted) (cf. Section 6.7 for a discussion on potential to address invasions through non-regulatory means).
van Wilgen et al. (2026)	Streamlining alien species listing processes to enable prioritisation and reporting in protected areas: The case of alien plants in South African National Parks	Outlines the processes used by South African National Parks to compile lists of alien taxa, with recommendations for future lists. The data assist with estimating '3.1 *Alien species richness*', and other species and site indicators.
Zengeya et al. (2025)	Lessons and challenges in creating alien species lists: insights from South Africa's national reports on the status and management of biological invasions	Outlines how South Africa's lists of alien taxa were developed and have changed over time (cf. Sections 2.1, Table S2.3)
Zengeya et al. (in press)	A list of alien taxa for South Africa	A summary of the list and metadata for South Africa's list of alien taxa (cf. Appendices 6–8).

Box 2.2 The B-Cubed Project

The Biodiversity Building Blocks for Policy project (B-Cubed) (Groom et al. 2025; https://b-cubed.eu/) is a multi-partner, collaborative project funded through the European Research Executive Agency and coordinated by the Meise Botanic Garden, Belgium. The overarching objective of the B-Cubed project is to develop pipelines to improve the integration of biodiversity data into data cubes that are then used as the basis for models and indicators to monitor biodiversity status and change. The simplest data cube is species occurrence data over time (species × site × time) with uncertainty estimates for each dimension (Groom et al. 2025). However, the data cube approach can be extended to use different types of data (e.g., on impacts of alien species). By automating analyses, the approach provides a mechanism for turning information into a regularly updated dashboard.

SANBI and Stellenbosch University (through the Centre for Invasion Biology) are two of the 12 partner organisations in the project. This report, i.e., 'The Status of Biological Invasions and their Management in South Africa', is a 'use case' for B-Cubed products. The data cubes, models, and indicators developed under the B-Cubed project provide information on five indicators used in the status report: changes in the '2.1 *number and status of alien species*', '2.2 *extent of alien species*' and '3.1 *alien species richness'* were tracked over time at various scales (e.g., Figures 2.1–2.3 and 3.1); and the potential for mapping '2.4 *impact of alien species*' and '3.3 *impact of invasions*' has been assessed [cf. Boulesnane-Guengant et al. (2025) for an example of the approach for alien *Acacia* species in South Africa]. This information thus helps address three of the six identified key gaps in previous reports (alignment of indicators, mobilisation of spatial data, and mobilisation of impact data) (Zengeya and Wilson 2023).

Alignment of indicators Standards for developing national level indicators to monitor biological invasions and their application are often lacking, and this impedes our ability to estimate progress made towards meeting global biodiversity targets (Section 0.2.2; McGeoch et al. 2023). B-Cubed has developed workflows to calculate indicators used to monitor biological invasions in a standardised way. Moreover, the B-Cubed project is assessing the types and quality of data required to inform the indicators; the processes used to collect, aggregate, and harmonise data; and workflows and processes used to calculate indicators and to report on trends. This work has facilitated the exchange of practical experiences on the processes used to inform the indicators and reporting, including indicator alignment, data availability, and gaps.

Mobilisation of spatial and impact data B-Cubed has used the species occurrence cube format for a range of analyses to monitor biodiversity status and change. It is documenting the workflows and scripts that are used to generate the cubes, ensuring that they are interoperable with other data cubes, particularly those that include environmental variables. The B-Cubed process to create the species occurrence cubes has been integrated with processes of the Global Biodiversity Information Facility (GBIF) and the species occurrence cubes can be downloaded based on GBIF-mediated data. Moreover, the process is designed to follow the FAIR data principles. For instance, downloaded data are assigned metadata and a unique digital object identifier to enable FAIR citation; adaptable workflows are easy to use and fully annotated; standardised biodiversity indicators are presented to track and understand biodiversity status and trends; and all products are freely accessible through project's website.

BIODIVERSITY BUILDING BLOCKS FOR POLICY

Box Figure 2.2. The Biodiversity Building Blocks for Policy project (B-Cubed) kick-off meeting in Brussels, Belgium, March 2023 **(**https://b-cubed.eu)

3. Sites

Lead authors: Tsungai A. Zengeya; Brian W. van Wilgen; Masingitla P. Mtileni

Contributing authors: Johan Baard, Richard Burns, Carlo De Kock, Katelyn Faulkner, Llewellyn Foxcroft, Zanele Jele, Emily McCulloch-Jones, Mahube Makuse, Marco Meyer, Welri Nortje, Mashudu Phalanndwa, Alanna Rebelo, Heiner Riffel, Mfundo Tafeni, Zikhona Sokudela, Nicola van Wilgen, Bongani Zungu

Findings for sites

- Alien species are distributed across the country, with most broad-scale administrative units and biogeographical regions being invaded by a variety of taxa. Most alien species are found in the Western Cape, Eastern Cape, and KwaZulu-Natal.
- Recorded alien species richness is highest around major urban centres. A recent increase in recorded alien species richness around urban areas is due to an increase in records from citizen science platforms such as iNaturalist.
- The National Invasive Alien Plant Survey (2008–2023) estimated changes in the levels of plant invasions in terrestrial biomes and water catchment areas. The biomes with the largest proportion of invaded land are the Indian Ocean Coastal Belt (11%), Fynbos (5%), Albany Thicket (3%), and Grassland (3%). Six of the primary catchment areas (those that were also Strategic Water Sources Areas) had a relatively high cover of invasive plants (4–10%). Most of the plant taxa have increased in cover despite mechanical and chemical control efforts, but there were decreases in cover for taxa under biological control.
- Biological invasions continue to cause major impacts on biodiversity, ecosystem services, and human livelihoods by reducing South Africa's water resources, degrading pasturelands, and exacerbating fires. These estimates need to be regularly reassessed.

Gaps for sites

- Data on the distribution and abundance of alien species need to be collected, collated and integrated into national and global databases to facilitate the planning of interventions. For example, due to the absence of monitoring programs, there are no reliable estimates for the relative abundance of invasive species at sub-national levels (for example protected areas).
- The systematic quantification of the impacts of biological invasions would: facilitate the prioritisation of interventions targeting particular species and particular sites; provide the justification for government investment to control biological invasions; and provide important background to communicate the issue to society.

Invasion-specific outcomes

3. *Extent of area that suffers 'Major' impacts from invasions*

3.1. *Alien species richness*

3.2. *Relative invasive abundance*

3.3. *Impact of invasions*

3.1. Alien species richness

Alien species are distributed across the country, with differences in alien species richness recorded across provinces, biomes, primary catchments, and marine ecoregions (Table 3.1; Table S3.1–S3.2). At the provincial scale, there has been substantial changes in alien species richness since the last reporting period (Table 3.1). Most alien plant species are found in the Western Cape, KwaZulu-Natal, Eastern Cape, with Northern Cape having the least number of alien plant species (Table 3.1a). The greatest increase in alien plant taxa per province was in Limpopo, Northwest, and KwaZulu-Natal, and low increases were found in the other provinces (Table 3.1a). Savanna, Fynbos, and Grassland biomes have the highest number of alien plant species, and the Desert and Forest biomes have the least number of alien plant species and the lowest increase in alien plant species richness (Table 3.1b). Alien freshwater fish species are distributed across most primary catchments, except Buffels River catchment that is alien-free (Table 3.1c). A total of 13 primary catchments (59%) have at least 10 alien freshwater fish species, e.g., Mfolozi, Berg, and Komati rivers (Table 3.1c). There have been recent changes in alien freshwater fish species in five primary catchments (Table 3.1c). The estimates of alien species richness for marine ecoregions presented in the last report (cf. Robinson et al. 2020) have not been updated due to the lack of comprehensive data for marine taxa in South Africa from the Global Biodiversity Information Facility (GBIF).

Information on *alien species richness* was also available for SANParks and Cape Nature protected areas (Table 3.1e). A total of 1 469 alien and invasive species (excluding biocontrol agents and marine species) are now recorded across the SANParks estate – a 48% increase from 2022. The increase in the recorded species richness across the SANParks estate between 2022 and 2025 is primarily due to recent efforts to revise and update previous lists of alien and invasive plants found within the estate (van Wilgen et al., 2026). This revision consolidated various data sources, including historical management and research reports, ornamental plant records from Kruger National Park rest camps and staff facilities that had been previously excluded, citizen science observations (e.g., iNaturalist), and peer-reviewed publications (e.g., Foxcroft et al. 2017). Several challenges were encountered when merging information from different data sources, including outdated taxonomy, spelling inconsistencies, and duplicate records, all of which required extensive data cleaning and verification. The review subsequently produced data pipelines, workflows, and recommendations that can be used to guide and inform conservation practitioners that aim to develop similar processes to develop a consolidated list of alien species in protected areas under their management. Of the 1 469 alien species recorded within the SANParks estate, 276 plants and 74 animal species are currently listed under the A&IS Regulations (Table S3.4).

The distribution of alien species across protected areas within the SANParks estate is highly skewed. Three protected areas (Garden Route National Park, Kruger National Park, and Table Mountain National Park) have recorded more than 300 alien species each (including species that have formed native-alien populations) (Table S3.3). This is largely due to survey effort, the size of the parks, the biome(s) that they cover, and the alien taxa listed for each park (i.e., ornamentals are included in the list for Kruger National Park but not for other parks). The Groenkloof National Park is the only protected area within the SANParks estate that is listed as alien-free, and the Meerkat and Grasslands national parks had the lowest species richness likely because of low survey effort.

As noted in previous reports, the alien species richness for birds and plants appears to be highest around major urban centres in Gauteng, KwaZulu-Natal, and Western Cape, likely due to greater survey efforts in those areas and because some species are commensal with humans and most species were first introduced in urban centres (Figure 3.1a, c; Figure S3.1). Information on *alien species richness* from municipalities was only supplied by the City of Cape Town and City of Ekurhuleni (Table 3.1f). In 2022, there were 104 taxa that are reported to occur across the areas managed by the City of Cape Town (Table 3.1f). The majority of these were plants (98 taxa) and the remainder are three terrestrial invertebrates (*Euwallacea fornicatus*, *Polistes dominula*, *Vespula germanica*), two birds (*Anas platyrhynchos*, *Corvus splendens*), and an amphibian (*Amietophrynus gutturalis*). Of these taxa 79 are listed under the A&IS Regulations, and the remaining 27 taxa are unlisted. In 2025, the total number of alien taxa in areas managed by the City of Cape Town has increased to 284 taxa (Table S3.3), mainly due to new records of plants (272 taxa) and a few species of legally released biological control agents for alien plants (*Cyrtobagous salviniae*, *Dactylopius* spp., *Lysanthia* spp., *Megamelus scutellaris*, *Neohydronomus affinis*), and a bird (*Acridotheres tristis*). The number of taxa listed under the A&IS Regulations has also increased to 123 and 161 taxa are unlisted.

There are 34 alien taxa that are reported to occur across the areas managed by the City of Ekurhuleni (Table 3.1f). The majority of these are plants (28 taxa) and the remainder are two terrestrial invertebrates (*Harmonia axyridis*, *Euwallacea fornicatus*), three birds (*Acridotheres tristis*, *Anas platyrhynchos*, *Columbia livia*), two fishes (*Cyprinus capio*, *Micropterus salmoides*) and two mammals (*Rattus rattus*, *Rattus norvegicus*) (Table S3.3). All of these taxa are listed under the A&IS Regulations, except *Euwallacea fornicatus*. These estimates have not been updated in 2025.

Table 3.1. Alien species richness in South Africa for different broad-scale administrative units and biogeographical regions. The estimates of change are made with low confidence because most reported increases arise from the formal recording of species that have probably been present for some time. The values are based on records from the Global Biodiversity Information facility (GBIF) (https://www.gbif.org) and the Southern African Plant Invaders Atlas (SAPIA) for continental South Africa; and Robinson et al. (2020) for marine ecoregions. Further details are provided in the Supplementary Material; see Appendix 6] for the full list of alien taxa.

a) Alien terrestrial and freshwater plant species richness per province.

Province	End of 2022	End of 2025	Change
Eastern Cape	881	915	34
Free State	482	514	32
Gauteng	782	826	44
KwaZulu-Natal	1 046	1 092	46
Limpopo	663	774	111
Mpumalanga	775	792	17
Northern Cape	366	400	34
North West	440	502	62
Western Cape	1 027	1 063	36

b) Alien plant richness per biome.

Biome	End of 2022	End of 2025	Change
Albany Thicket	583	613	30
Desert	41	46	5
Fynbos	1 031	1 065	34
Forest	166	189	23
Grassland	1 021	1 076	55
Indian Ocean Coastal Belt	784	822	38
Nama-Karoo	337	349	12
Savanna	1 157	1 209	52
Succulent Karoo	297	349	52

c) Alien freshwater fish species richness per primary river catchment.

Primary catchment	End of 2022	End of 2025	Change
A–Limpopo	10	10	0
B–Olifants North	10	10	0
C–Vaal	10	10	0
D–Orange	8	9	1
E–Olifants West	8	8	0
F–Buffels	0	0	0
G–Berg	18	18	0
H–Breede	10	10	0
J–Gouritz	8	8	0
K–Krom	11	11	0
L–Gamtoos	7	7	0
M–Swartkops	8	8	0
N–Sundays	5	5	0
P–Bushmans	7	7	0
Q–Great Fish	7	7	0
R–Keiskamma	13	13	0
S–Kei	9	10	1
T–Mzimvubu	15	15	0
U–Mkomazi	19	19	0
V–Tugela	12	13	1
W–Mfolozi	13	14	1
X–Komati	12	13	1

d) Marine invasive species richness per marine ecoregion (not updated for 2025).

Marine ecoregion	End of 2022
Agulhas	41
Natal	25
Delagoa	8
Southern Benguela	39
Southeast Atlantic (offshore)	0
Southwest Indian (offshore)	0

e) Alien species richness in areas managed by the City of Cape Town and City of Ekurhuleni. [Note: information from the City of Cape Town and City of Ekurhuleni have been requested to update the status of alien species richness in areas under their respective management. This section will be updated when this information is received]

Metro	Group	End of 2022	September 2025	Change
City of Cape Town	Grasses, annuals, vines	45	87	42
	Trees and shrubs	53	185	132
	Terrestrial invertebrates	3	8	5
	Fishes	NA	NA	NA
	Amphibians	1	1	0
	Birds	2	3	1
	Mammals	NA	NA	NA
	Total	**104**	**284**	**180**
City of Ekurhuleni	Grasses, annuals, vines	11	NA	NA
	Trees and shrubs	17	NA	NA
	Terrestrial invertebrates	2	NA	NA
	Fishes	2	NA	NA
	Amphibians	NA	NA	NA
	Birds	3	NA	NA
	Mammals	2	NA	NA
	Total	**37**	**NA**	**NA**

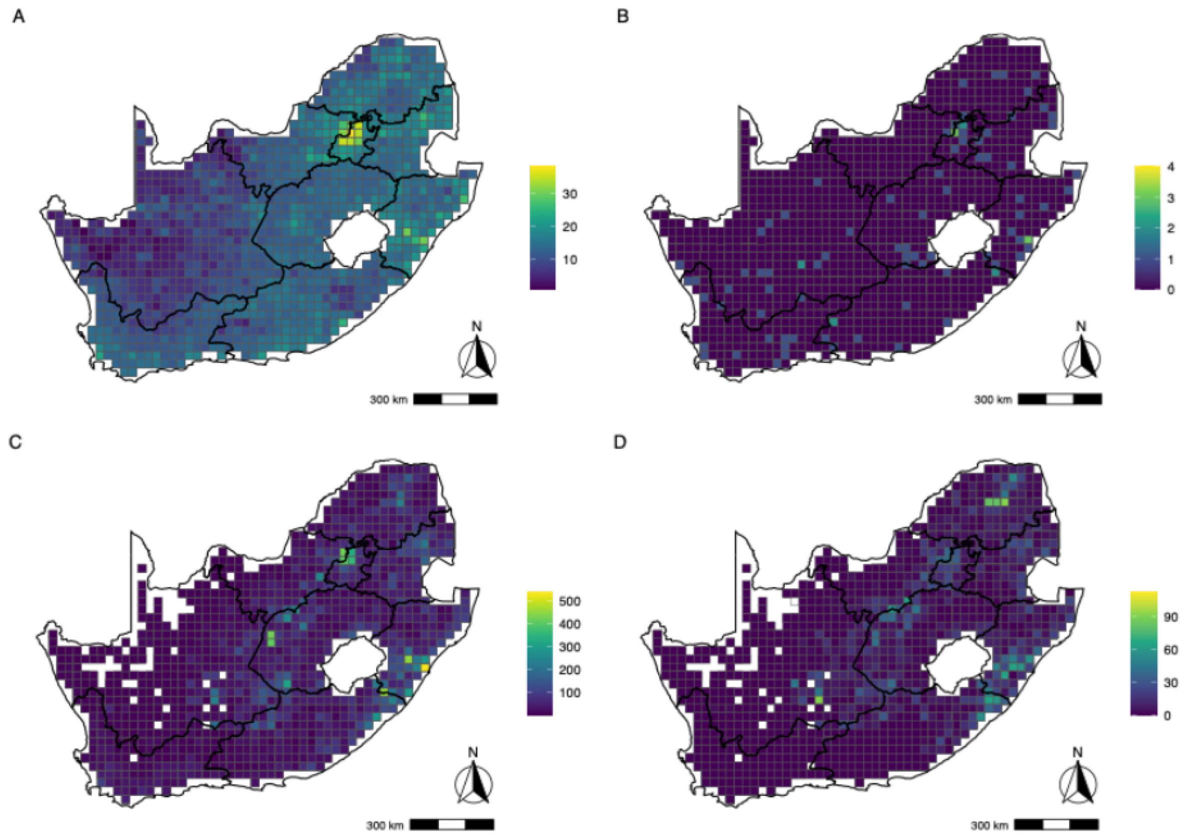


Figure 3.1. Alien species richness of birds and plants in South Africa per quarter degree grid cell (QDGC) as of December 2025 and the change in these values since December 2022. A) alien bird species richness; B) increases in alien bird richness; C) alien plant richness; D) increases in alien plant richness. Maps are based on occurrence records from GBIF and SAPIA.

3.2. Relative invasive abundance

The national-scale survey of invasive plants provided estimates for changes in the *relative invasive abundance* of selected species between 2008 and 2023 in terrestrial biomes and water catchment areas in South Africa (Kotzé et al. 2025). The Indian Ocean Coastal Belt was the most invaded terrestrial biome, with 11% of the remaining natural vegetation invaded, followed by the Fynbos (5%), Albany Thicket (3%) and Grassland (3%) biome (Table 3.2). There was a significant increase in cover between two surveys for the Indian Ocean Coastal Belt (79%), Forest (36%), Nama Karoo (23%) and the Fynbos (20%). Wattles (*Acacia dealbata*, *A. decurrens* and *A. mearnsii*) and *Eucalyptus* species occupied the largest area and spread more rapidly than other taxa, but the relative contribution of taxa differed between biomes (Table S3.5). In contrast the proportion of invaded area decreased for the Desert (34%), Albany Thicket (12%), and Succulent Karoo (18%). These decreases in the proportion of invaded area are likely due to a decrease in cover of *Acacia* trees and succulent cactus shrubs for the Albany Thicket, as well as a decrease in *Neltuma* species in the drier Desert and Succulent Karoo biomes. This decrease in cover is likely because of successful biocontrol programmes, especially against the cactus shrubs (e.g., Paterson et al. 2021).

Table 3.2. Changes in the extent of invasion by 14 alien plant taxa in nine terrestrial biomes in South Africa from two successive surveys. Based on data from Kotzé et al. (2025)

Biome	**Biome area (km^2)**	**Area of remaining natural vegetation (km^2)**	**Invaded area in 2008 (km^2)**	**Invaded area in 2023 (km^2)**	**% change**	**% of remaining natural vegetation invaded**
Indian Ocean Coastal Belt	1542	850	525	939	79	11
Fynbos	8489	6288	2701	3241	20	5
Albany Thicket	3115	2792	875	773	-12	3
Grassland	32541	21984	5127	5411	6	3
Savanna	40457	34896	3534	3723	5	1
Forest	444	413	20	27	36	<1
Nama Karoo	25913	25473	781.5	962	23	<1
Succulent Karoo	8728	8469	178.1	147	-18	<1
Desert	734	721	18.4	12	-34	<1

Strategic Water Source Areas (SWSAs) are areas of land that either supply a disproportionate (i.e., relatively large) quantity of mean annual surface water runoff in relation to their size or are areas that have high groundwater recharge and where the groundwater forms a nationally important resource (Le Maitre et al. 2018). In South Africa, SWSAs generate more than half of the country's surface water runoff from only 10% of the land, with key groundwater recharge areas contributing up to 42% of river baseflow and maintaining flows during dry periods. Kotzé et al. (2025) assessed the impact of plant invasions in six primary catchments that have more than 50% of their area classified as SWSAs (Table 3.3). The six primary catchment areas had a relatively high cover of invasive plants (4–10%) (Table 3.4), compared to the national average of 1.5%. There was significant increase in cover (22–32%) for five of the six primary catchments that was mainly driven by increases in the estimated cover of *Acacia*, *Eucalyptu*s and *Pinus* species (Table S3.6). The exception was the Swartkops catchment, where cover decreased by 19%. The Swartkops catchment is situated predominantly in the Albany Thicket biome, where similar decreases in cover were noted due to a decrease in cover of *Acacia* trees.

Table 3.3. Changes in the extent of invasion by 14 alien plant taxa in six primary catchments in South Africa from two successive surveys done in 2008 and 2023 respectively. SWSA is Strategic Water Source Area. Only six primary catchments are shown (those with >50% of their area classified as SWSAs). Data are from Kotzé et al. (2025), see Table S3.6 for information on the other 16 primary catchment areas.

Primary catchment	Catchment area (km^2)	Proportion (%) of catchment in SWSA	Proportion (%) of catchment invaded (2023)	% Change from 2008
Berg	25 322	59	5	28
Breede	15 353	50	4	22
Kromme	7222	67	10	23
Swartkops	2628	79	7	-19
Mzimvubu	46 679	69	5	32
Nkomazi	18 343	72	6	32

3.3. Impact of invasions

van Wilgen et al. (2008) performed a biome-scale assessment of the impact of invasive plants on ecosystem services in South Africa. This study has been pivotal in our understanding of the impacts of invasive plants (invasive trees in particular) in South Africa, but the study has not been updated or revised. There was a recent unsuccessful attempt to replicate these estimates and develop transparent and repeatable workflows that could be used to update the figures and track changes over time, therefore no updated estimates are possible (see Supplementary S3.3 for more details).

Recent studies have proposed alternative methods for estimating the impacts of plant invasions on surface water runoff (e.g., Le Maitre et al. 2016; Moncrieff et al. 2021). However, the key challenge is to develop a method that is scalable to the national level while still capturing local-scale variation. Recent studies have incorporated remote sensing with evapotranspiration models to monitor and assess impacts of plant invasions (e.g., Rebelo et al. 2025, Cogill et al. 2025, and Box 3.2). For example, a study in selected river catchments (Luvuhu, Sabie-Crocodile, Tugela and uMzimvubu) found that invasive trees cover about 10% of the catchment areas, mostly in SWSAs where water resources could be increased by between 6 to 176 million m^3 across catchments by clearing invasive trees (Rebelo et al. 2025).

3.4. High level indicator 3: *Extent of area that suffers 'Major' impacts from invasions*

Biological invasions continue to cause 'Major' impacts on biodiversity, ecosystem services and human livelihoods by reducing South Africa's water resources, degrading pasturelands and exacerbating fires. These estimates, however, have not been recently revised.

Impacts are likely to increase as invasive species continue to spread and as control efforts are scaled back in response to fiscal constraints. This underscores the importance of refocussing control efforts on agreed priority sites and taking steps to improve control effectiveness. If control efforts focus on priority sites (e.g., sites that provide water to South Africa's towns and cities – SWSAs) then significant returns on investment could be realised. However, without agreement on priorities, there is a substantial risk that control could remain ineffective, and the area that suffers from 'Major' impacts will continue to grow. Estimates of the full magnitude of impacts require more accurate assessments of the extent of invasions. This, in turn, requires effective mapping of the areas invaded and monitoring of spread. Such monitoring is currently lacking, and without which effective prioritisation is not possible.

Box 3.1 A study to track the extent and abundance of invasive species

The Working for Water Programme commissioned a national-scale survey of selected high-priority invasive plants in 2007. The survey was completed in 2008 and repeated between 2016 and 2023. The survey was intended to track trends in cover of 14 plant taxa (at species, genus or family level) on 47830 plots of 100 × 100 m, using observers in low-flying aircraft. The taxa included *Acacia cyclops*, *A. saligna*, *Arundo donax*, *Chromolaena odorata*, *Lantana camara*, *Melia azedarach*, and *Solanum mauritianum*, the genera *Acacia* (other than *A. cyclops* and *A. saligna*), *Eucalyptus*, *Hakea*, *Neltuma*, *Pinus* and *Populus*, as well as succulents in the family Cactaceae.

The findings of this study were reported for the first time in 2025 (Kotzé at al. 2025). Although the study only covered a relatively small number of species (31), it provided data to inform the indicator for trends in the extent of alien species. It was possible to report, for these species at least, trends in the extent of occupation at a national level, as well as at the level of invasions in terrestrial biomes and primary water catchment areas. The study found both increases and decreases in extent, with decreases being attributed to biological control (see section 4.8).

The study was similarly useful for estimating the abundance of the selected species. In the previous three reports, it was noted that this indicator could not be assessed due to a lack of information. An estimate can now be provided for 14 taxa, including 31 species. Although there are many more species for which abundance cannot be estimated, the sample reported by Kotzé et al. (2025) covered species of a high priority on which > 60% of the money has been spent on control over the past two decades (van Wilgen et al. 2022b).

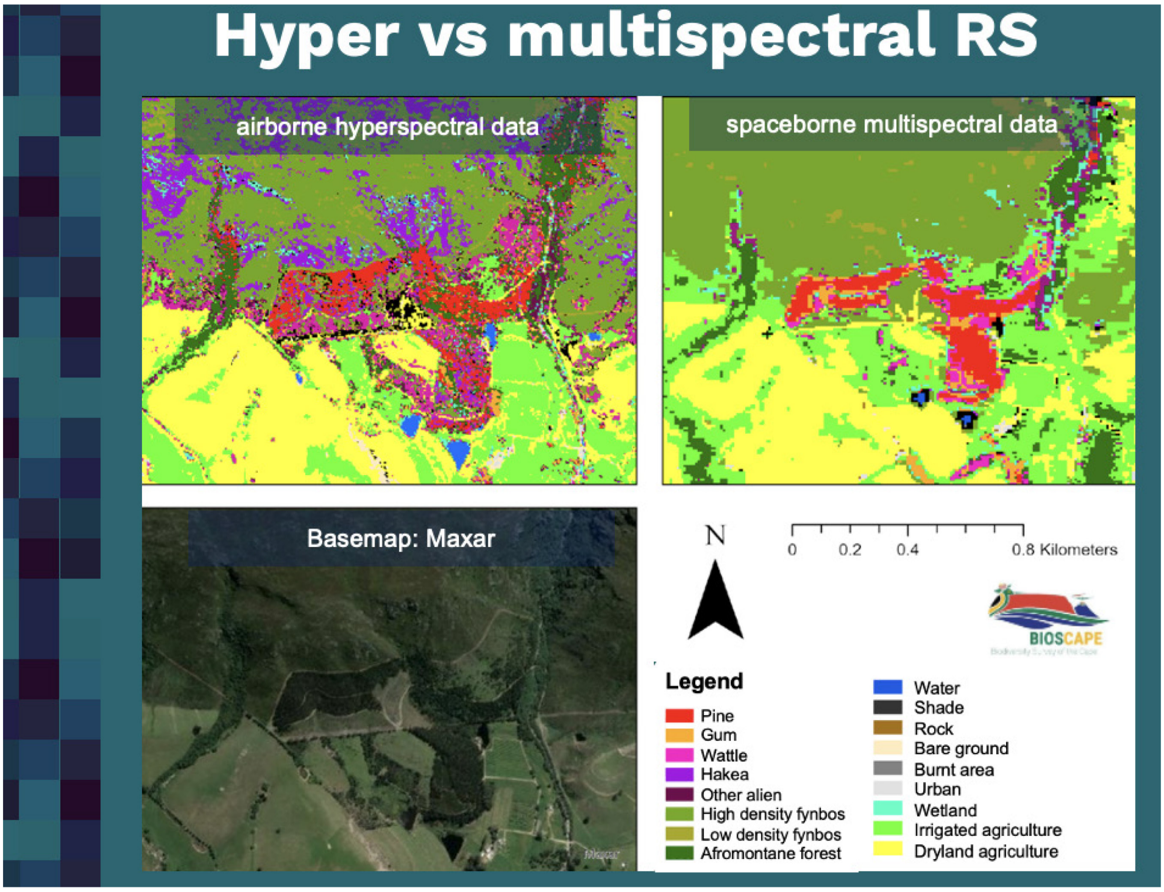
This study was intended to provide a reliable monitoring system to inform management on trends in the extent and abundance of the priority species that were being managed in the country. Recent substantial cuts in funding (see Section 4.2) have meant that this monitoring programme has been discontinued. Earth observation through satellite remote sensing can potentially fill the gap, but several challenges need to be overcome (Box 3.2).

Box 3.2 The use of remote sensing to monitor plant invasions

Remote sensing is the use of satellites, drones, or aircraft to collect information about the Earth's surface without physical contact. Recent technological advancements in satellite sensors, cloud computing, and machine learning have expanded the potential for using remote sensing to map invasive plants and to monitor the extent of invasions and their impacts (Box Figure 3.1). The open data movement has created additional opportunities, for example freely available satellite imagery from Europe's Copernicus programme (Sentinel-2), free cloud computing via the Google Earth Engine platform, and the researchers who make their code and packages available to others. This has improved accessibility of remote sensing for ecological applications, particularly in resource constrained regions.

South Africa has a reasonably long history of using remote sensing to map invasive plants, particularly trees. Most research has been exploratory, and therefore patchy (e.g., van den Berg et al. 2013, Meijninger and Jarmain 2014, Holden et al. 2021). Recently the National Invasive Alien Plant Survey combined modelling with remote sensing imagery to produce a national-scale alien plant map (Kotzé et al. 2025), with detailed distribution data for 14 invasive tree taxa (Box 3.1). However, the map is for a single point in time and there are no plans to repeat the survey on which it was based, and as such it will rapidly become out of date. A new project, named 'Mapping Woody invasive Alien Plant Species' (MAPWAPS) has been piloted in six regions of the country with the goal of producing an easily updatable national map (Rebelo et al. 2025). This project focuses on woody plants at the genus level (e.g., *Acacia*, *Eucalyptus,* and *Pinus*) although some herbaceous taxa are included and there has been some success in distinguishing species (e.g., 99% accuracy in distinguishing between different Australian *Acacia* species in the Eastern Cape; Skosana et al. 2025).

While remote sensing holds promise, several challenges remain. It is not always possible to distinguish invasive species from native vegetation, particularly when invasions are sparse (scattered or young individuals) or are herbaceous and grow under or among other species. The acquisition, storage, and processing costs needed for high resolution imagery can be prohibitive or rely on companies providing free access (that might be subsequently withdrawn). Finally, maps are often not accurately or appropriately interpreted, especially when local ecologists are not included in the interpretation. The inclusion of ecological expertise and in-field validation will continue to be vital if the benefits of technological advances in remote sensing are to be realised; supplemented by citizen science data if processing and curation standards are adequate.



Box Figure 3.2. A comparison of classifications done with two different types of remote sensing imagery (hyperspectral vs multispectral) in the Swartberg, South Africa (Source: Rebelo et al. 2025).

4. Interventions

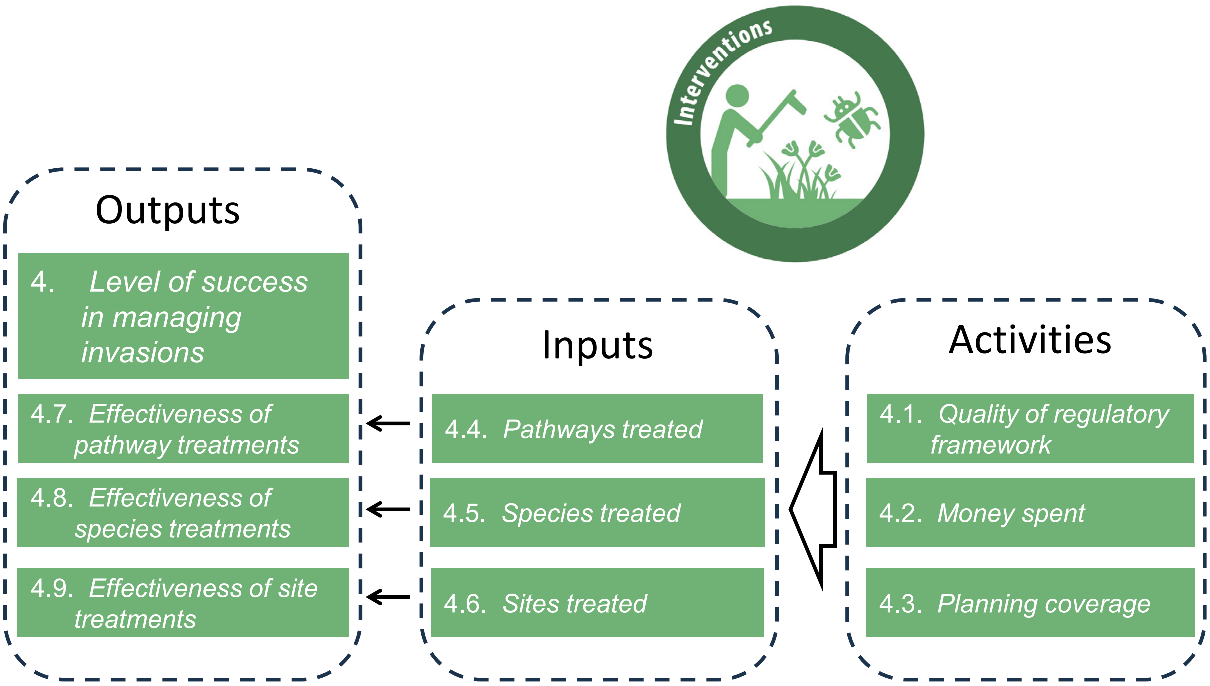
Lead authors: Brian W. van Wilgen, John R. Wilson, Katelyn T. Faulkner

Contributing authors: Felipe Balocchi, Sarah Davies, Michelle De Bruyn, Paul Fourie, Marcini Govender, Martin Hill, Minette Karsten, Carina Malherbe, Themba P. Mnguni, Bheka Nxele, Iain Paterson, Louise Stafford, Mfundo Tafeni, Karabo Wanjau, Andrew Wannenburgh, Costas Zachariades

Findings and gaps for interventions

- There have been no significant legislative changes (2023–2025). However, draft amendments to the NEM:BA were published, a national strategy has been drafted, the evidence base in support of listing taxa is growing, and procedures regarding compliance and enforcement are being implemented.
- Government investment to manage biological invasions has declined by over 50% (2023–2025).
- Even at the previous levels of investment, it was estimated that spending was 4% of that needed to bring invasions under complete control.
- No pathway-management plans have been prepared. No species-management plans have been approved. 48 site-management plans for organs of state have been approved by the DFFE—fewer than 7% of organs of state have an approved site-management plan.
- There is partial management in place for many pathways, management focuses on specific species that pose a threat to agriculture or human health or is not national in scope.
- The effectiveness of interventions for pathways is not monitored by the management agencies that implement them. Available estimates for the effectiveness of pathway management indicate management is ineffective, with illegal and accidental introductions continuing.
- The Border Management Authority (BMA) became fully operational in 2023. >39 000 inspections for environmental threats at ports of entry were conducted in 2024, an overall decline since 2022.
- The BMA intercepted an illegal import of the red claw crayfish (*Cherax quadricarinatus*) at OR Tambo, with the offender arrested and convicted.
- Monitoring of the effectiveness of control interventions that targeted invasive species remains largely absent, and available information is patchy.

- Recent studies of interventions aimed at the control of invasive species found eight management interventions to be partially effective, three ineffective, and one counter-productive.
- A remote sensing survey found *Acacia cyclops*, *A. saligna*, cacti (family Cactaceae), and *Hakea sericea*, all of which are under biological control, decreased in cover at a national level, while all other surveyed species not subjected to biological control had increased in cover.
- WfW ceased funding the research and implementation of biological control at the end of 2022.
- The invaded area increased by 78.8% between 2008 and 2023 in the Indian Ocean Coastal Belt biome, and there were also substantial increases in the Forest, Nama Karoo, and Fynbos biomes (36, 23, and 20% respectively), the cover decreased in the Desert, Succulent Karoo, and Albany Thicket biomes by 34, 18 and 12 % respectively.
- The Working for Water programme has discontinued the recording of sites treated. The total area over which alien plant control interventions were conducted is thus not known.
- Formal systems to monitor the outcomes of site treatments are not in place. Research studies that have assessed the effectiveness of control interventions report partial effectiveness—the native vegetation that established after control was typically reduced in species richness. Further interventions are needed if full restoration is to be achieved.



4.1. Quality of regulatory framework

Between January 2023 and December 2025, the primary legislation governing biological invasions in South Africa (the NEM:BA of 2004) did not change nor were the A&IS Lists or Regulations promulgated under the Act revised (Figure 4.1). No new significant relevant international commitments were agreed to (the GBF was agreed in December 2022). However there have been some significant developments. Draft amendments to the NEM:BA were published in May 2024, a national strategy has been drafted, the evidence base in support of the regulatory listing of taxa has been developed, and procedures regarding compliance and enforcement are being implemented. These are discussed in turn below. This section concludes with a discussion of how the regulatory framework is being implemented.

4.1.1 Legislative revisions

The National Environmental Laws Amendment Act, 2022 (NEMLAA) was passed by the President in June 2022, and came into effect 30 June 2023. The Amendment Act amended, among other Acts, NEM:BA. Once NEMLAA commences, NEM:BA will have clearer definitions of the terms 'eradicate' and 'control'. It is also clearer from the text that invasive species must be either eradicated or controlled depending on what is possible under the circumstances (presently landowners and other role-players are required to both eradicate and control invasive species). Furthermore, NEM:BA will no longer require landowners to notify competent authorities of the presence of invasive species on their land. The Minister will have the power to specify the circumstances under which such notification must be given.

A White Paper on the 'Conservation and Sustainable Use of South Africa's Biodiversity' was published on 14 June 2023. Biological invasions were referred to in one policy objective: "*1.4. Identify and manage harmful, and potentially harmful, invasive species, their potential and existing introduction pathways and biological invasions.*" The White Paper represents an important step, but as the White Paper does not cover all aspects of biological invasions (e.g., the focus is on biodiversity rather than the impacts invasive species have on built-infrastructure and food security) it is unclear if it would negate the need for a policy specifically on biological invasions. Lukey and Hall (2020) make it clear that law can be used to implement policy. If a law does not make provision for a means to implement policy, it may be necessary to introduce new laws or regulations. A White Paper is a precursor to law, but there is still no policy on biological invasions, so it is not immediately clear what has informed the drafting of references to invasions in the White Paper.

A ‘Draft National Environmental Management: Biodiversity Bill’ was published for public comment in the government gazette on 24 May 2024, i.e., immediately before the 2024 general election. A primary aim of the bill is to “…*provide for the management of the impacts of invasive species*”, and in general terms the intention seems to be to simplify what is in the NEM:BA with details to be published in future regulations. It is not clear at what stage the revisions have reached. Until the Bill is promulgated (and NEM:BA 2004 is repealed), revised regulations cannot be published.

4.1.2 A national strategy on biological invasions

A national strategy on biological invasions (formally the National Invasive Species Strategy and Action Plan, NISSAP[21]) has been under development for several years, led by the DFFE with input from other departmental officials and scientists from the SANBI. Various consultations have happened, including a national stakeholder meeting (21–22 November 2024), but the full draft is yet to be made available for public comment. In August 2025, the draft was shared with the members of Working Group 1[22], and the intention is for the strategy to go for public comment in the 2026/27 financial year.

4.1.3 Processes to provide evidence to inform the listing of alien taxa

The rationale for including taxa on the A&IS Lists[23] is not clearly set out anywhere. To ensure that structured evidence informs revisions to the lists, a process has been set up to produce and review risk analyses (see Figure 5.2D, with details in Wilson and Kumschick 2024). Risk analyses are produced using the Risk Analysis of Alien Taxa Framework (RAAT). The RAAT framework was recently updated to v2.0 to i) clarify descriptions; ii) remove superfluous questions; and iii) add questions to fully justify recommendations (Kumschick et al. 2025). There is still a need, however, to integrate all the information in the risk analyses with the information presented in the list of alien taxa (Appendix 6) and ensure that information collated can easily feed to and from international databases.

Risk analyses are produced by whomever is interested in influencing the listings, these are evaluated by the DFFE and/or SANBI as appropriate and sent by SANBI to an independent scientific body for

[21]The NISSAP is intended to cover all aspects of biological invasions, not just invasive species. The phrasing is to align with the CBD.

[22] Working Group 1 is formed under Chapter 3, section 41(1) of the Constitution and fosters the principles of co-operative government and intergovernmental relations. Working Group 1 is made up of national, provincial, and local government officials, and they meet quarterly to discuss and address challenges related to biodiversity and conservation—be it policy, frameworks, action plans etc. These groups are responsible for providing guidance and recommendations to Ministerial sectoral and technical meetings (MINMEC and MINTECH). From there, as appropriate, the strategy would go to the relevant Cabinet and/or Portfolio committees in Parliament.

[23] For full details of the current (and past) NEM:BA A&IS Lists see Wilson (2025).

review (the Alien Species Risk Analysis Review Panel, ASRARP). The risk analysis once approved by ASRARP is submitted by SANBI to the DFFE for consideration. The DFFE, as appropriate, tables it at a cross-governmental decision-making body (the Risk Analysis Review Committee, RARC) and recommendations to revise the regulatory listings are made. The intention is that such recommendations will be published along with the risk analyses to justify future revisions to the A&IS Lists (though as discussed above, this will only happen after the revised Bill is promulgated).

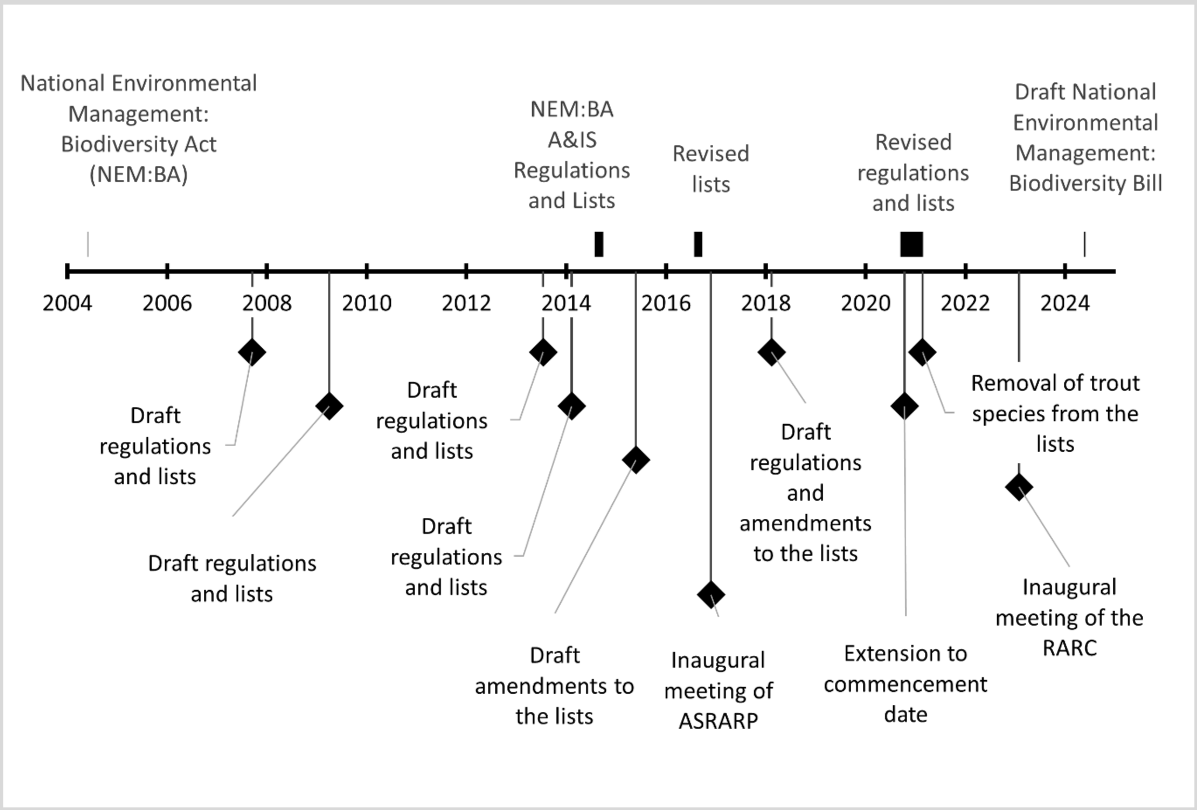


Figure 4.1 Timeline of the development of the Alien and Invasive Species Regulations under the National Environmental Management: Biodiversity Act (NEM:BA A&IS Regulations). Adapted and updated from Wilson and Kumschick (2024). ASRARP is the Alien Species Risk Analysis Review Panel (an independent body) and the RARC is the Risk Analysis Review Committee (a governmental decision-making body). See Wilson (2025) for full details of the A&IS Regulations and Lists to date. In 2020 the regulations did not come into effect when they were supposed to as there was an 'extension to the commencement date'. The regulations came into effect in March 2021 with the removal of trout species from the lists. This figure was produced using a template from the programme Vertex42.

By the end of December 2025, risk analyses for 170 taxa have been evaluated by ASRARP and submitted by SANBI to the DFFE, including 148 of the 560 listed taxa (Table S4.1), i.e., over a quarter of all listed taxa. Between January 2023 and December 2025, risk analyses on 77 taxa were submitted by SANBI to DFFE, slightly more than the period 2020–2022 (68 taxa). Of the risk analyses completed on 77 taxa (2023–2025), 68 were regarding currently regulated taxa (of those not regulated, five recommended regulating as present in the country and two to be added to a prohibited list), only for

36 of these was there no change recommended to the nomenclature (though as previously this was mostly about dropping synonyms). In 26 out of the 68 regulated taxa there was a recommended change to the listing (~38%, slightly less than in previous period 25/58). This is not, however, of immediate concern as many of the changes are due to the intention to simplify listings and as those taxa with controversial listings have been prioritised for evaluation.

The Risk Analysis Review Committee (RARC) had its inaugural meeting on 2 February 2023, is meeting quarterly, and addressing four to five risk analyses at each meeting (thus keeping pace with the rate at which risk analyses are being produced, though not as yet clearing the backlog). The RARC have considered ~40 risk analyses as of end December 2025. The intention is that decisions of the RARC (and supporting risk analyses reviewed by ASRARP) will be made public when revisions to the A&IS Lists are published for public comment (this will only happen after the new Act has been promulgated).

4.1.4 Implementation of the regulatory framework

Technically the quality of the regulatory framework is an input (cf. Figure 0.2). Discussion on the implementation of the regulatory framework addresses activities (pathways, species, and sites treated; e.g., the number of inspections carried out and prosecutions) and outputs (levels of compliance or remedial actions taken). However, as these activities are consolidated in terms of those responsible (i.e., largely DFFE officials in terms of the A&IS Regulations), the implementation of the regulatory framework is discussed here.

[Note: the permit database is still to be updated, the following two paragraphs will be updated accordingly when that update is made]

The process for issuing import permits is described in Figure 5.2E with variation for biological control agents in Figure 5.2F. XX import permits were issued by DFFE in 2023–2025 for XX taxa with some of these for research and display purposes; by comparison XXX import permits were issued on XX taxa in the period 2015–2022 (no permits were issued in 2014). Discuss trend. Notably during 2023–2025 no permits were issued to import species not already legally in the country, except to import classical biological control agents (X-ref).

The process for issuing permits to conduct activities on taxa listed under the A&IS Regulations is described in Figure 5.2G. During 2023–2025, XXX permits were issued (excluding import permits and permits for research, biological control, or display purposes that can be issued for any listed taxon). At ~XXX permits per year comparison with an average of ~XXX per year for 2015–2022) (Figure XXX).

Notably, of the 117 listed taxa for which there is provision for permits to be issued for their usage in the 2020 lists (i.e., category 2) XX taxa have never had a permit issued, a further XX taxa have had five or fewer permits issued, but the XX most frequently permitted taxa have had over XXX permits each [in order XXX] (see Table XXX; for the full list of permits see Appendix 6).

DFFE conducts various inspection activities regarding compliance (Fig. 5.2J), as well as enforcement that can lead to criminal prosecutions (Fig. 5.2K). As part of this report, various types of information that are needed to facilitate these processes are outlined Table 5.3. However, it is not clear if these data have been collated yet and are not reported here. [Note: awaiting information on the numbers of successful prosecutions under the A&IS Regulations in the period covered by this report]. There are, however, some noteworthy examples of the process being applied, for example, see Section 4.7 for a discussion of a successful prosecution related to pathways.

Chapter 5 discusses several issues and sources of information that will need to be addressed if the regulatory framework is to be implemented effectively. For example, import permits are only required for alien taxa that are not legally in the country (Figure 5.2E), however, such a list does not exist. Without access to the information outlined in Table 5.3, and more broadly indications of cases of missing data or reports (e.g., how many permits should have been issued for a given taxon if everyone were compliant) it is not possible to fully evaluate the extent to which the regulations are being effectively implemented.

4.2. Money spent

McCulloch-Jones et al. (2024) quantified costs from available information and estimated that ZAR 9.6 billion (expressed in 2022 values of ZAR) had been spent managing biological invasions in South Africa between 1960 and 2023, noting that this was just 4% of the money predicted as being necessary for management (ZAR231.8 billion in 2022 values, based on models that used estimates from studies of the potential costs to manage biological invasions). This study also noted that the cost of damage caused by invasions far exceeded expenditure on control, that almost all management had focussed on a few invasive plant species, and that there were large gaps in information that reduced the level of confidence in the estimates. Notably, however, there is very little reliable information on the money spent on managing biological invasions. Data are not routinely recorded, curated or reported in consistent ways, and so there is significant uncertainty associated with the findings.

What seems clear is that the money spent has been declining. DFEE budgeted ZAR 0.92 billion to manage biological invasions 2023–2025, a decrease of ~54% from the ZAR 2.02 billion expended 2020–2022 (values are adjusted to 2025 values of ZAR).

There have also been notable shifts in spending (Table S4.2). Most notably, the amount spent on biological control research and implementation 2023–2025 was 17% that of 2020–2022 (Figure 4.2).

This decline was mainly due to the termination of funding from the DFFE's Working for Water programme to the Centre for Biological Control (CBC) at Rhodes University and to the Agricultural Research Council's Plant Health and Protection unit (ARC-PHP) at the end of 2022. While the CBC has not been able to conduct research in this field over the past three years, the ARC-PHP has received some funding from the Department of Agriculture (DoA) and the Global Environmental Facility. The DoA funding has supported research into biological control of *Acacia dealbata* (silver wattle), *Cestrum* species, *Parthenium hysterophorus* (parthenium), *Solanum elaeagnifolium* (silver-leaf bitter apple), and the operation of facilities for the mass-rearing and release of biological control agents.

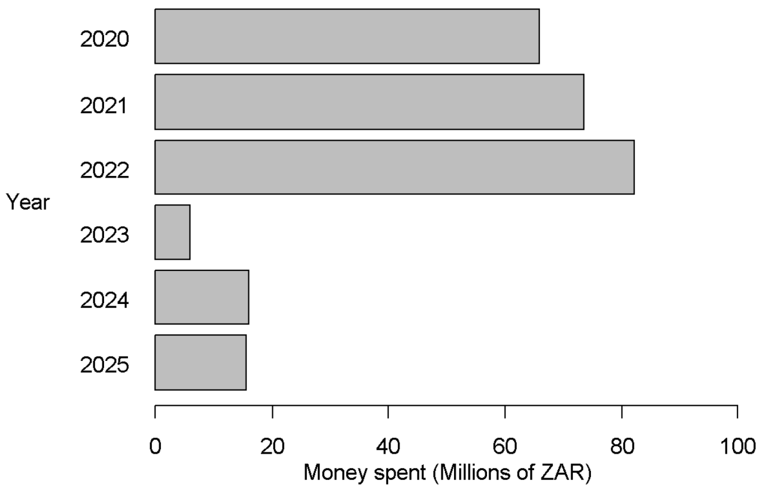


Figure 4.2 The amount of money spent annually on the biological control of invasive plants in South Africa. Figures are adjusted for inflation to 2025 values of ZAR. DFFE stopped funding biological control at the end of 2022 with funds coming from other sources (e.g., the DoA). For the actual values see Table S4.2.

National conservation agencies (South African National Parks and the Isimangaliso Agency) received a greater proportion of the budget. For example, all funding in the Western and Northern Cape provinces went to South African National Parks, i.e., the provincial authorities in those provinces receiving no funding 2023–2025.

An additional amount was budgeted to be spent on value-added products, i.e., the conversion of biomass from alien plants into furniture and other products (see Section 4.9 on outcomes below). The annual totals for value-added products (adjusted to 2025 values of ZAR) indicate that ZAR 73.8 million was budgeted for 2023–2025, a decrease of 60.9% from that spent 2020–2022. Biomass to produce value-added products is obtained from a range of sources and not necessarily from alien plant control projects alone, nor is it clear whether the income from these products is invested back into control interventions (van Wilgen et al. 2022b).

The quality of the record keeping also seems to be declining. Since 2022, information on spending has not been recorded in DFFE's Water Information Management System (WIMS), and the DFFE only supplied the amounts budgeted for individual projects for each year. These budgets are less detailed than the WIMS data (for example the area cleared and the species treated are not reflected). Estimates of money spent on the management of biological invasions in South Africa are thus unreliable. Moreover, the money spent by various entities was largely sourced from the Working for Water program, and thus summing these amounts would lead to double counting (cf. Table S4.2). Information on money spent was also only received from a few organisations (no estimates of spending were received from provincial environmental departments and the only municipalities who provided estimates were Cape Town and Ekurhuleni).

The Border Management Authority (BMA) has spent on managing pathways and border posts. The amounts spent have been requested from the BMA, but that data have not yet been received.

The Greater Cape Town Water Fund (GCTWF, Stafford et al. 2018) spent ZAR 184.4 million (adjusted to 2025 values of ZAR) on the control of invasive trees in the catchments of the Theewaterskloof, Berg River and Wemmershoek Dams, the Voelvlei Dam, the Steenbras Dam, and the Atlantis Aquifer (2023–2025; Table S4.2). Spending (2023–2025) was mainly directed towards follow-up work. Due to declining funding from government sources, the proportion of work funded by the GCTWF at these sites increased from 47.6% in 2020 to 77.9% in 2025.

The City of Cape Town reported having spent ZAR 140.3 million (2023–2025). Of this 125.5M was on alien plants, 5.6M on alien animals, and 9.2M on the polyphagous shot hole borer. The City of Ekurhuleni (Gauteng) spent ZAR 37.7 million 2023–2025 on the control of invasive species in 384 ha. The eThekweni (Durban) and Cape Town metros have spent ZAR 3.27 million (adjusted for inflation to 2025 values of ZAR) on attempts to eradicate House Crows 2023–2025.

4.3. Planning coverage

4.3.1 Pathway management plans

To address Target 6 of the GBF, pathway management plans (also termed 'pathway action plans') should be developed for pathways that have been prioritised for management and for which management is feasible (CBD and IUCN 2024; see Section 5.7). In South Africa, there is no legal requirement for pathway management plans under the A&IS Regulations nor under any other relevant regulations, and there has been no national exercise to prioritise pathways for management or to determine the feasibility of such management. Ballast water management plans have reportedly been developed for eight ports, but a 2012 study found that only three such plans (Port of Saldanha Bay, Port of Ngqura, and the Port of Durban) could be produced (Calitz 2012). The ballast water management plan for one of these ports (Saldanha Bay) is still well-recognised and details several mechanisms to track and control ballast water release (Anchor Environmental Consultants 2024). Nonetheless, the requirements set out in these plans differ (Calitz 2012) (see Section S4.3 for further details).

Recent guidance has been provided at an international level as to what pathway action plans should contain (CBD and IUCN 2024)—pathway action plans should set out strategic actions (e.g., at-border checks, methods to minimise contamination, codes of practice, awareness raising) that need to be taken for each pathway. While the actions outlined in these plans should be informed by international agreements, and the guidelines and standards linked to these agreements, additional, national actions are still required (see Section S4.3 for further details of what pathway action plans should contain). The pathway management plans that have been developed for South Africa do not follow these pathway action plan guidelines.

4.3.2 Species-specific management plans

For species, the NEM:BA [Section 75(4)] requires the Minister to ensure the coordination and implementation of 'Prevention, Control or Eradication of Invasive Species Programmes' (hereafter species-specific management plans). To this end, the Minister may also establish an entity consisting of public servants to coordinate and implement these programmes.

No species-specific management plans have been formally adopted, although, as discussed in previous reports, plans have been prepared for two species [*Parthenium hysterophorus* (parthenium) and *Campuloclinium macrocephalum* (pompom weed)], two genera [*Acacia* (wattles) and *Neltuma* (formerly *Prosopis*, mesquite)], and one family [Cactaceae (cacti)] of invasive plants. [We are awaiting information on species plans for alien plants that are targets for national eradication.]

Although biological control agents are identified, screened and released for the control of specific invasive plant species, there are no formal species-specific management plans to guide these interventions, or to integrate them with other control methods.

A detailed strategy and control plan for the house crow (*Corvus splendens*) was compiled by a multi-stakeholder group consisting of national government, provincial government, municipalities, SANBI, the Centre for Invasion Biology, and other invasion biologists (DFFE 2023). The overall objective of the strategy is to prevent the establishment of a permanent house crow population in South Africa by eradicating all existing populations and any subsequent arrivals. This Strategy provides a framework for achieving this objective, including by setting six goals with timelines and responsibilities. It also seeks to coordinate actions between various role players and to facilitate the release of resources. The strategy is designed to give effect to the requirements of NEM:BA for organs of state to prepare invasive species monitoring, control and eradication plans for land under their control. The strategy estimates that South Africa will have to commit ZAR 8 million per year for at least the next three to five years to achieve the objectives and goals, with costs reducing thereafter, but there will be a surveillance and rapid response requirement in perpetuity. The strategy stresses that failure to commit these resources and fully implement the strategy will result in the certainty of establishing a permanent and abundant population of house crows and transferring costs and impacts to future generations. The strategy was submitted to the DFFE in March 2023 but has not yet been approved.

The Department of Agriculture has developed an emergency plant pest response plan (Department of Agriculture, no date). The aim of the plan is to outline an effective rapid response for the detection, identification, and mitigation of an emergency plant pest incursion in South Africa. The plan covers methods and actions to control of the spread of a pest during the early stages of incursion; to determine if eradication is possible; to provide effective and timely communication between stakeholders at all levels about when responses are needed; to protect unaffected areas and to maintain production and business continuity in affected areas during a plant pest emergency. Funds will need to be used for the coordinated management of resources within government, research and industry institutions.

4.3.3 Site-specific management plans

The NEM:BA section 76 (2) (a) requires all organs of state in all spheres of government to prepare an ‘Invasive Species Monitoring, Control and Eradication Plan’ (hereafter a site-specific management plan) for land under their control. Section 10 (2) of the A&IS Regulations state that organs of state in all spheres of government must prepare their site-specific management plan based on prescribed guidelines, and submit those plans to the Minister and to SANBI. The guidelines are based on criteria listed in NEM:BA section 76 (4), and include a list of all invasive species; description of the parts of that land that are infested with such listed invasive species; the extent of such infestation; the efficacy of previous control measures; the current measures to monitor and control invasive species; and measurable indicators of progress.

In addition to the requirements under NEM:BA, management authorities of protected areas are required to submit a protected area management plan to the Minister or the MEC for approval in terms of the National Environmental Management: Protected Areas Act (NEM:PAA, Act 57 of 2003). These plans include the need to manage biological invasions but were not assessed for this report.

Details of the site-specific management plans are captured by the DFFE in a database. The database includes the name and location of the site, the date of submission of the plan, the period for which the plan is valid and whether the plan has been approved. The plan is evaluated by the DFFE in terms of whether it meets the required criteria and is either approved or returned for revision if necessary (Figure 5.2I). Importantly, as discussed above, the database does not include the management plans prepared in terms of the NEM:PAA.

The DFFE has received 216 site-specific management plans since 2016 (Table S4.3). Plans were submitted by conservation agencies, municipalities, metros, and a variety of organs of state (e.g., Eskom, SANRAL, the Ports Authority, and the Airports Authority), as well as for privately-owned areas. Of the 128 plans prepared by state-owned landowners, 48 (37.5%) have been approved and signed off, while 56 of the 88 plans submitted by private landowners (63.6%) have been approved and signed off. The area covered by the plans (in hectares) is not recorded on the DFFE's database. In addition, the period for which the plan is valid has not been captured, and it is thus not possible to estimate the value for the indicator for planning coverage (the proportion of the relevant area covered by plans). The largest number of plans submitted came from the Western Cape (63% of the plans from state-owned land and 92% from private landowners, Table S4.3).

SANBI has developed a strategy for the management of biological invasions within National Botanical Gardens (SANBI 2025). The main aim of the strategy is "*To anticipate, prevent entry, and where feasible and/or necessary, control biological invasions* [in National Botanical Gardens and the National Zoological Garden]*, in an effort to minimise their negative impacts on the ecological integrity of protected indigenous biodiversity*" (SANBI 2025, adapted from Freitag-Ronaldson 2005). The strategy notes that plans have been developed for the Free State, KwaZulu-Natal, Kwelera, and Kirstenbosch National Botanical Gardens, and others are being developed. These have not yet been included in the DFFE's database or assessed.

Table 4.2 The number of site-specific management plans submitted to the DFFE since 2016 by state-owned and private landowners. Since all organs of state are required to have plans in place, the number of plans approved shown be equal to the number of entities. A list of all organs of state that require a site is not available (Table 5.3), noting that many organs of state do not manage land. The process for the evaluation of such plans is outlined in Figure 5I.

Entity	Number of entities	Number of plans	Number of plans approved
Private	> 7 000 000	88	56
Municipalities	249	45	No data
Provincial protected areas	427	34	No data
Other organs of state	No data	25	No data
National Parks	21	17	No data
Metros	8	14	No data

4.4. Pathways treated

Forty (40) of 44 pathways are managed to some extent and this has not changed since December 2022. However, for half of these pathways (20), management is partial (e.g., focusing only on specific species that pose a threat to agriculture or human health or not being national in scope, see Section S4.5). For example, South Africa is a signatory to the International Maritime Organisation (IMO) and must give effect to the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM) through national legislation. The Ballast Water Management Bill was drafted in 2013 and went out for public comment in 2017, but as of February 2025, it had not been enacted (Parliamentary Monitoring Group 2025). Ballast water management is currently only implemented at a few ports [e.g., Saldanha Bay (Anchor Environmental Consultants 2024)]. An important pathway that is still not managed is biofouling on aquatic vessels. The guidelines for managing biofouling developed by the IMO were recently updated, and the updated version adopted in 2023 (IMO 2023). The development of a legally binding framework for the control and management of ships' biofouling has been approved (https://www.imo.org/en/ourwork/environment/pages/biofouling.aspx).

The Border Management Authority (BMA), which was established through the Border Management Authority Act of 2020, became fully operational in 2023. This represents a major change in the way many pathways are managed (Box 4.1), integrating functions previously performed by various government departments at ports of entry (see Figure 4.3 for ports of entry through which alien species can be legally imported).

There have been changes since 2022 to the operations carried out by DFFE at OR Tambo International Airport. Between January 2023 and August 2025 ~81 200 inspections at OR Tambo International Airport were performed for environmental threats, with most of these being performed at the arrivals (~56 700) and departures (~23 000) terminals (Figure S4.4). Notably this represents a decline in the number of inspections – in 2022 ~46 500 inspections were undertaken, but in 2023 there were ~27 700 inspections and in 2024 there were ~ 39 100 inspections (Figure S4.4). As of December 2022, officials performed inspections at the mail centre; at the arrivals, departures and cargo terminals; and at the private terminal, Fireblade (Figure 5.2A). Inspections continue to be performed at most of these locations, but in 2023 the Mail Centre relocated from the OR Tambo International Airport precinct to the new Germiston Mail Centre, and consequently inspections of the mail were halted until September 2025. Since 2023 inspections of cargo and at Fireblade have been hindered by transport challenges. These changes, delays in the deployment of x-ray scanners, and capacity constraints have contributed to the reduced number of inspections. Financial constraints have meant that there has been a reduction in the number of inspectors employed. An arrangement was initiated to assist with inspections for CITES listed species - this has exacerbated capacity constraints.

Details on the cargo inspections were recorded for 2023, and as for 2020-2022, almost all the imported cargo consignments inspected (99% of ~73 consignments) were of *Psittacula krameri* (rose-ringed parakeet), with one consignment inspected for *Centrochelys sulcata* (spur-thighed tortoise). These taxa are listed under the A&IS Regulations [see Appendix 6 and Wilson (2025) for details]. Such information on cargo inspections is no longer recorded, and so cannot be reported on for 2024 and 2025.

Inspections for agricultural threats (of imported plants, animals and their products) are performed at various ports of entry and other sites (e.g., National Plant and Plant Product Inspection Services regional offices). If a suspected plant pathogen or pest is found during an inspection, tests are performed for 'quarantine pests' by Plant Diagnostic Services. Plant Diagnostic Services also performs these tests on 'audit samples', and some imported animals and plants are also kept under quarantine while further tests are done. 'Quarantine pests' are those that have been assessed through a pest risk analysis, have been deemed to pose an unacceptable risk to agriculture, and are prohibited from entering the country (in terms of agricultural regulations rather than the A&IS Regulations). There are also several other biosecurity initiatives that focus on agricultural pests, including public-private partnerships (see Box 4.1).

[Inspection data for agricultural threats has been requested from the BMA, but has not yet been received]

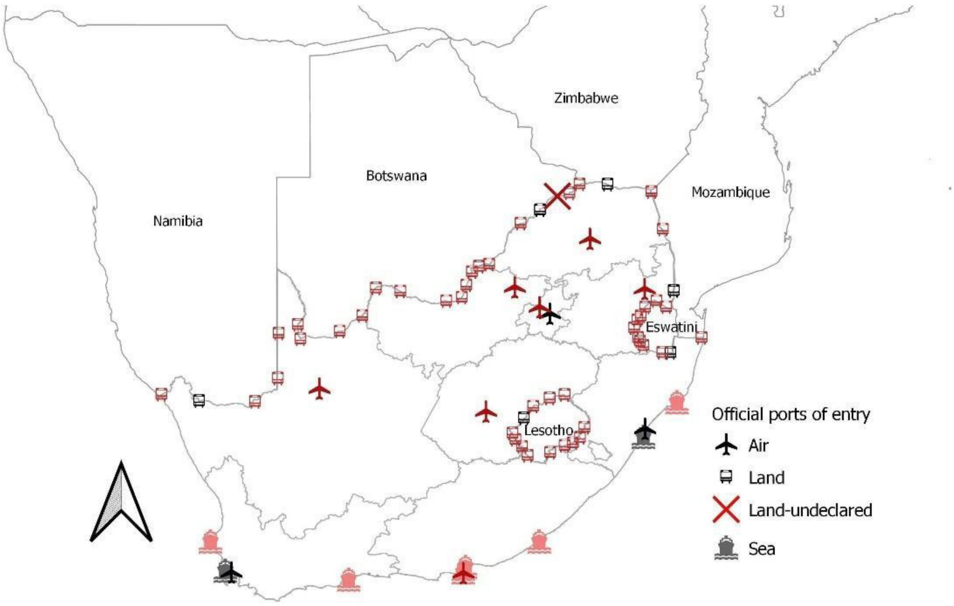


Figure 4.3. Alien species can be legally imported through 11 of South Africa's 71 official ports of entry. Ports of entry through which alien species can be imported are shown in black, other ports of entry are shown in red. The red cross on the map represents Zanzinbar, a port of entry between South Africa and Botswana that was withdrawn in November 2023.

4.5. Species treated

A national list of alien taxa in South Africa has been developed, in which it is recorded whether the species has received treatment, and what the effectiveness of that treatment has been (Zengeya et al. in press). Control interventions have been directed at 183 taxa (out of 560) listed under the A&IS Regulations, and a further 136 taxa that are not listed. Information on species treated has been derived from several sources, including published accounts and submissions from a range of government agencies, NGOs and private individuals in response to requests for such information. Most information on government-funded interventions was historically sourced from the WfW Water Information Management System (WIMS). The WIMS system is no longer consistently used, and Working for Water was unable to provide a list of species that had been treated over the past three years. Requests were made to organs of state, provincial conservation agencies and municipalities and metros to provide this information, but only two submissions were received. The City of Cape Town carried out control interventions aimed at 210 alien taxa (of which 118 were listed under the A&IS Regulations), and the City of Ekurhuleni carried out interventions aimed at the control of 11 listed alien species (10 plants and one freshwater fish). Studies published over the past three years have assessed the outputs and outcomes of interventions to control 11 species (5 terrestrial plant species, two aquatic plant species, two insect species and one pathogenic fungus, see supplementary Table S4.4 for details).

Several alien species have been identified as potential targets for national eradication. Information on these has been requested and will be included in this report when received.

Biological control of invasive plants has targeted 66 species (Zachariades 2021). In many cases, this control continues without the need for further management interventions, but in some cases (for example for aquatic plants) continued management in the form of mass rearing and release of agents is required. Four new biological control agents were released against four target invasive plant species between 2023 and 2025 (Table 4.3).

Table 4.3 Biological control agents released in South Africa between 2023 and 2025. Information supplied by the Plant Health and Protection unit of the Agricultural Research Council.

Target invasive plant species	Biological control agent	Year first released
Acacia dealbata	*Perilampella hecateus*	2023
Sagittaria platyphylla	*Listronotus appendiculatus*	2023
Salvinia minima	*Cyrtobagous salviniae* (Florida)	2025
Tecoma stans	*Heikertingerella* sp.	2023

A total of ZAR413 768 was spent eThekwini (Durban) metro to manage house crows 2023–2025. Another project has been ongoing in the Cape Town metro during the period covered by this status report (DFFE 2023), but recent details were not available.

Control interventions are ongoing for many other species that have been subjected to control in the past, even though funding has declined over the past three years. However, compiling a list of all species subjected to control interventions every three years cannot be made with confidence at this stage.

4.6. Sites treated

The area over which alien plant control interventions were conducted 2023–2025 is not known. Most of the information was historically sourced from WIMS, but this system is no longer consistently used, and WfW was unable to provide the details of areas that had been treated over the past three years. In addition, no information was obtained from organs of state, provincial conservation agencies, and municipalities and metros, with three exceptions. South African National Parks indicated that alien plant control interventions were implemented in 18 of the 22 national parks under their management, and the City of Cape Town submitted management plans indicating that alien plant control interventions were implemented in 11 nature reserves. The City of Ekurhuleni reported that invasions were managed over an area of 384.4 ha. Private landowners and volunteer groups (cf. Box 4.2) also manage invasions at particular sites, incorporating such contributions into the report remains a significant gap (Chapter 6).

4.7. Effectiveness of pathway treatments

There is no systematic monitoring of pathway treatments, and their effectiveness is not assessed by the management agencies that implement them. Therefore, the effectiveness of pathway treatments was determined based on recently published data and data obtained from management agencies. For 24 of the 44 pathways (55%) there is either no management or management was ineffective [for 13 pathways (30%) the effectiveness of management could not be estimated]. There has been little change since December 2022 to the estimated effectiveness of pathway management, with the estimates remaining the same for 93% of pathways. In many cases, recently published research or data obtained from management agencies confirmed the assessment made in the previous report (Section S4.6).

There was one instance of a prosecution arising from inspections carried out by DFFE at OR Tambo International Airport between January 2023 and August 2025. In January 2024, 158 live freshwater crayfish weighing 30kg were found in the luggage of a traveller at the international passengers arrival terminal. The individual, a repeat offender who was previously found with *Eriocheir sinensis* (Chinese mitten crab), was arrested and charged in accordance with the NEM:BA. The crayfish were identified by experts at the Pretoria Zoo as *Cherax quadricarinathus* (red claw crayfish), currently listed as 1b. The case resulted in a conviction, and the offender was fined R 50 000. Such interceptions, as well as various studies (see below for discussion on these studies), indicate that intentional introductions (the focus of these inspections) are not being effectively managed.

Studies on the pet trade have confirmed that the management of this pathway is ineffective, with poor co-operation and ambiguous lines of responsibility posing a challenge to the effective regulation of parts of this trade (Shivambu et al. 2024a; Vezi et al. 2024). Up until 2014 a 'safe' list approach (Kumschick et al. 2024) was followed for imports of ornamental fish (DEA 2015). Yet of the 312 species included in an inventory of the trade only 77 are on that list (Vezi et al. 2024). The current process is unclear, but it does not appear to be in line with other import processes (cf. Figure 5.2E) and such imports have not been recorded in the DFFE's permit database. There is therefore significant concern around the legality of alien ornamental fish imports. The traded species included 13 that are invasive in their global introduced range, four recorded as invasive in the country, and one which has had 'Major' impacts (*Micropterus salmoides*) on South Africa's freshwater systems (Vezi et al. 2024). It is currently unclear whether DFFE or DoA is responsible for the management of ornamental fish importation records, and freshwater and marine fish permit records are not available. The records that do exist have not been digitised (Vezi et al. 2024). Alien pet birds are escaping from captivity, although some of the escaping species are already found outside of captivity and are listed in the A&IS

regulations, including *Acridotheres tristis* (category 3, common myna), *Anas platyrhynchos* (category 3, mallard), *Columba livia* (category 2 and 3, rock dove), *Psittacula krameri* (category 2, rose-ringed parakeet), and *Sturnus vulgaris* (category 3, common starling) (Shivambu et al. 2024a). *Psittacula krameri* was the third most reported pet bird species escaping from captivity (149 reports of lost birds, 82 of found birds, and 12 sighted), with only *Psittacus erithacus* (grey parrot) and *Nymphicus hollandicus* (cockatiel) having more reports (Shivambu et al. 2024a). These findings suggest that permitting is ineffective in stopping escapes, and therefore that relisting might need to be considered.

The management of the horticulture/ornamental plant pathways also appears to be ineffective. Almost half of the alien tree species planted in the town of Prince Albert (28 of 62 species) are listed under the A&IS Regulations. Importantly, most of these regulated tree species were also self-seeding (Milton and Dean 2025), representing spread from ornamental plantings. Similarly, of the 94 alien plant species planted within the Tshwane University of Technology grounds, almost a half (43 species) are listed in the regulations (Nelufule et al. 2024). While some of these plantings may have been before the regulations were first promulgated in 2014; these is evidence that alien taxa listed in the regulations are still being sold at nurseries (Rodríguez-Cala et al. 2025b).

A comprehensive dataset of agricultural inspections performed by DoA (Saccaggi et al. 2021) has been used in several national and international studies, which have indicated that harmful species are likely slipping through the borders with imports of plants and their products. One of these studies attempted to estimate the effectiveness of South Africa's interventions to prevent insect introductions with fruit imports (Shabangu 2023). The study implemented a method developed by Bacon et al. (2012), which is applicable for situations like that in South Africa, where the data available are not ideal for estimating effectiveness. The study concluded that there appear to be biases in inspections; and that there are pathways that should receive more attention based on the risks posed. The study also highlighted potentially harmful species that have not yet been recorded the country but are likely to slip through border control because of these biases. Many of these were thrips (*Frankliniella intonsa*, *Frankliniella schultzei, Thrips fuscipennis*, and *Thrips major*), but the mealybug, *Maconellicoccus hirsutus*, whose introduction was prohibited under the A&IS Regulations of 2016, was also shown to have a high risk of being introduced. There were far more interceptions of non-quarantine species than quarantine species, which could be due to the efforts of exporters to ensure consignments are free of quarantine pests. However, non-quarantine pests could also pose a threat and should not be ignored. There were a few challenges to the implementation of the method, such as lack of transparent, comprehensive watch lists (or quarantine lists), and a large proportion of the records not being identified to species level (~50%). There are several reasons why there is taxonomic uncertainty in inspection data (see Saccaggi and Ueckermann 2024), and while this issue poses a challenge to estimates of intervention efficacy, it also importantly poses a threat to the country's biosecurity (Saccaggi and Ueckermann 2024). An international study that used the data from South Africa highlighted that certain groups of insects are slipping through border controls and are establishing without being intercepted (Turner et al. 2025). For example, higher interceptions were recorded for plant feeding insects than other groups, which could reflect the emphasis on phytosanitary inspections at borders, but could also be due to differences across taxa in ease of detection (and identification), or variation in establishment probabilities (Turner et al. 2025). There have also been several recently recorded new alien species have that were likely introduced as contaminants of imported products (Section 1.2).

[Note: Inspection data for agricultural threats has been requested from the BMA, information will be added once received]

4.8. Effectiveness of species treatments

The absence of formal monitoring programmes remains a significant barrier to estimating the effectiveness of species treatments. Some information has been gleaned from a range of sources and is summarised below. However, the coverage is patchy, as reported in the previous report.

[Note: The list of alien taxa needs to be updated with new information to derive numbers].

In South Africa, 90 invasive plant species have been targeted for biological control using 136 agents, of which 92 are established on 66 target species (Zachariades 2021). Zachariades (2021) reported that 72% of the agents inflict some level of damage to the host plant, and 35% inflict extensive damage (Zachariades 2021). Moran et al. (2021) also evaluated the success of biological control on alien plant species in the country that have had agents released on them for long enough for biological control to have reached its full potential. Of the 54 targeted species considered, 39 have been reduced below pre-biological control levels for at least one of the metrics evaluated (density, biomass, area, rate of spread), and 15 have been reduced permanently to levels where they no longer have any negative impacts (Moran et al. 2021). Although this assessment was conducted in 2021, the benefits are permanent and have continued to contribute to a reduction in the negative impacts from invasive plants in South Africa in recent years. For the biological control agents released more recently (Table 4.3) it is too early to be able to assess their effectiveness.

Paterson et al. (2024) provides a review of post-release evaluations of biological control programs against invasive plants in South Africa. These assessments have been done at levels ranging from physiological changes within individual plants, plant growth parameters, plant population dynamics and landscape level changes. Twenty-three post-release evaluations were included in the Paterson et al. (2024) review, the majority of which provided evidence of a reduction in negative impacts at the level of the study (i.e., individual plant, population, or landscape level). In most cases, studies showed a reduction in the plant invasion but have not investigated the actual benefits accrued to ecosystems and society, except in a few cases (e.g., Coetzee et al. 2020; Motitsoe et al. 2020, 2022).

Post-release evaluations have provided direct evidence for the complete and permanent control of several cactus weeds such as *Opuntia stricta* (Hoffmann et al. 2020, Australian pest pear), *Cylindropuntia fulgida* (Klein et al. 2020, boxing-glove cactus), and *Cereus jamacaru* (Muskett et al. 2024, queen of the night cactus). The biological control of *Opuntia aurantiaca* (jointed cactus), although not considered under complete control (Moran et al. 2021), has had considerable benefits to society (Mnqeta and Paterson 2024). Invasive aquatic plants have also been assessed providing evidence that biological control has been effective against several important species including *Pontederia crassipes* (water hyacinth), *Salvinia molesta* (Kariba weed), *Azolla filiculoides* (Azolla), *Pistia stratiotes* (water lettuce) and *Myriophyllum aquaticum* (parrot's feather) with significant benefits (Coetzee et al. 2021; Coetzee et al. 2022). Both invasive cacti and aquatic plant species require mass-rearing and releases, with 81 releases totalling over 270 000 agents released on six invasive water weed species and 56 releases of over 10 000 agents for cactus weeds in 2024 alone (CBC Annual Report 2024). Augmentative releases of these agents have yielded positive results, improving levels of control (Coetzee et al. 2022; Moffett et al. 2024). Post-release evaluations also provide evidence for the substantial control of *Acacia saligna* (Port Jackson) (Wood and Den Breeyen 2021), as well as changes in trajectory of the invasion towards long-term reductions in populations of several Australian *Acacia* species that are targeted with seed-attacking biological control agents (Impson et al. 2021a,b).

The findings from two successive surveys of the extent of invasion by 32 invasive species (grouped into 14 taxa) at a national level was reported for the first time by Kotzé et al. (2025). The survey was completed in 2008 and repeated between 2016 and 2023. The cover of most taxa increased between the two surveys, but *Acacia cyclops* (rooikrans), *A. saligna*, cacti (family Cactaceae), and *Hakea sericea* (silky hakea), all of which are under biological control, decreased in cover. While other species increased despite biological control [e.g., *Acacia mearnsii* (black wattle)], all the surveyed species that were not subjected to biological control increased in cover. For many species, such as *A. mearnsii*, changes in cover such as those measured in Kotzé et al. (2025) would not have expected to have changes, as the agents have not been present in the system for long enough to have resulted in measurable impacts in plant density.

The biological control agent *Uromycladium woodii* (a pathogenic fungus) against the invasive tree species *Paraserianthes lophantha* (Australian albizia) is very effective with 100% mortality of trees. However, field observations now suggest that seedlings of *P. lophantha* are emerging from the soil seed bank, and they show no signs of infection with *U. woodii*. This is because the fungus has died off in localities where all its host plants have been eliminated. It has proved difficult to maintain a culture for the re- release of the fungus now that funding for this work has ceased. The intervention might therefore prove ineffective in the long term (A. Wood, Agricultural Research Council, personal communication).

There are few examples of attempts to control invasive pathogens, and it is an important aspect that requires attention. An example of such a species is *Phytophthora cinnamomi*, a globally recognised invasive plant pathogen. In South Africa, *P. cinnamomi* is known to cause root rot in endemic Proteaceae. Msweli et al. (2025) reported on a trial that used phosphite and assessed its effectiveness against *P. cinnamomi* infection in the indigenous tree *Leucadendron argenteum*. Phosphite was effective on seedlings in the glasshouse but proved to be ineffective in field trials.

An attempt to eradicate *Corvus splendens* (house crow) from South Africa has been ongoing, but control to date seems to be ineffective. During 2023–2025, 1882 birds were euthanised in eThekwini (Durban) metro, but the estimated population grew from 1000 birds in 2023 to 1200 birds in 2025. Another project has been ongoing in the Cape Town metro during the period covered by this status report (DFFE 2023), but recent details were not available. In addition, new populations have established in Pietermaritzburg and Richard’s Bay in KwaZulu/Natal province, and in East London, Gqeberha, and the general areas of Makhanda and Port Alfred in the Eastern Cape province, and populations are spreading and growing—the species has now established populations in seven coastal metros and municipalities (DFFE 2023). There are several major issues to address if eradication is to be achieved: sustained funding and sustained control will be essential if gains from control operations are not lost; given their high levels of intelligence, crows are very difficult to control at low density (and therefore to extirpate from a site); and there is no evidence to suggest existing introduction pathways have been effectively closed (and so, even if nation-wide extirpation was achieved, the expectation is that reinvasion would be swift).

Eight working groups have been established to improve the effectiveness of management of biological invasions (Table 4.4) by exchanging ideas and information and developing practical approaches to implementing potential solutions. These working groups have no legal standing or statutory role, but rather they constitute a community of practice that enables decision makers and researchers to work collaboratively while advancing projects through integrated decision-making. The effectiveness of these groups has only been assessed in the case of the Cape Invasive Animal Working Group, where Davies et al. (2020) concluded that their deliberations improved management effectiveness and helped to make decisions on interventions.

Table 4.4. Working groups established to share information and co-ordinate management interventions relating to biological invasions in South Africa.

Working group	Focus of activities	Geographical scope	Notes / Reference
Marine Alien and Invasive Species Working Group	Marine and estuarine organisms	Coastal provinces	Group was initiated but is currently inactive
Cactus Working Group	Plants in the family Cactaceae	National	Kaplan et al. (2017)
Alien Grass Working Group	Plants in the family Poaceae	National	Visser et al. (2017)
Australian Woody Plants Working Group	Tree and shrub species native to Australia	National	None
Cape Floristic Region Partnership Invasive Alien Animal Working Group	Vertebrate and invertebrate fauna	Fynbos Biome (Western and Eastern Cape provinces)	Deliberations by the group improved management effectiveness and helped make decisions on interventions (Davies et al. 2020)
KwaZulu/Natal Invasive Species Forum	All taxa	KwaZulu/Natal province	None
Eastern Cape Invasive Alien Species Forum	All taxa	Eastern Cape province	Currently in an inception phase.
KwaZulu/Natal Aquatic invasive working group	Aquatic plants	KwaZulu/Natal province	None

4.9. Effectiveness of site treatments

As reported previously, the scarcity of formal systems to monitor the outcomes of site treatments (i.e., changes in the populations of invasive species or ecosystem recovery after their removal) remains an obstacle to assessing the effectiveness of site treatments. Such assessments therefore must be based on a few studies. All these studies reported partial effectiveness of interventions as the native vegetation that established after control was typically reduced in species richness, and it was generally concluded that further interventions would be needed if full restoration was to be achieved (see Table S4.4 for details). Some notable findings are summarised briefly below.

Kotzé et al. (2025) reported that six primary catchment areas with > 50% of their area classified as strategic water source areas had between 4.4–10.1% cover of invasive plants, compared to the national average of 1.5%. This cover increased by between 21.9 and 32.3% in five of the six catchments between 2008 and 2023 despite ongoing control efforts. The exception was the relatively small Swartkops catchment, where the estimated invaded area decreased by 18.9%. Kotzé et al. (2025) also reported changes in invasive plant cover between 2008 and 2023 at the level of terrestrial biomes.

The most heavily invaded biome was the Indian Ocean Coastal Belt, where 11% of the remaining natural vegetation was invaded by alien plants. This was followed by the Fynbos, Albany Thicket and Grassland biomes with 5.2, 2.8 and 2.5% cover of invasive taxa respectively. For the remaining biomes, cover was 1.1 % or less. The invaded area almost doubled in the Indian Ocean Coastal Belt (78.8%) between the two surveys and there were also substantial increases in the Forest, Nama Karoo and Fynbos biomes (36, 23 and 20% respectively). On the other hand, the cover decreased in the Desert, Succulent Karoo and Albany Thicket biomes by 34, 18 and 12 % respectively.

Holmes et al. (2020) reported that ecosystem recovery after clearing invasive plants in fynbos vegetation was possible under certain circumstances if thresholds (e.g., with respect to the density or duration of invasion) had not been crossed. In contrast, Baard et al. (2023) reported good autogenic recovery after several decades of pine afforestation following removal of the trees and burning of the site. Baard et al. (2023) concluded that the restoration potential of the montane grassy fynbos in the study area was superior to that previously documented in montane proteoid fynbos.

Retief et al. (2024) reported successful restoration of sand fynbos vegetation after the removal of alien grasses, which was achieved by a combination of topsoil translocation, burning, sowing of seeds and transplantation of plants. This led to plant species richness resembling near-pristine plots. It was noted that the technique was potentially expensive and therefore probably only suited to use in small urban nature reserves.

Ruwanza (2024) used repeat surveys in 2019 and 2022 to examine vegetation and soil recovery after removal of invasive *Eucalyptus grandis* (saligna gum) trees from savanna vegetation. Trees were either felled and removed, or felled, stacked and burned. The study found some vegetation and soil improvements between 2019 and 2022 in both the fell-and-removal and fell-and-stackburn cleared treatments and concluded that there was a positive vegetation and soil recovery trajectory towards the condition in uninvaded control plots.

Romain and Ngwenya (2025) reported on the use of biomass from alien plant clearing projects. The intent of these projects is to generate income from a resource that would otherwise go to waste, to offset the costs of control, and in so doing provide additional opportunities for employment. Their report concluded however that the use of biomass from alien plant clearing programs involved, “*a complex governance of supply chains, without coordination with alien clearing programs, a diversity of models, and mixed reports about the fluidity of interactions with landowners*". There is also evidence from Kenya that a deliberate attempt to control the spread of *Neltuma* (formerly *Prosopis*) trees from Kenya failed to achieve this aim (Ng et al. 2017; Mbaabu et al. 2019). These studies therefore do not provide any evidence that the use of biomass from control interventions has (i) slowed or reversed the spread of invasive species; (ii) generated a surplus; and (iii) even if a surplus was generated, it is not known whether the surplus is re-invested into control efforts.

The use of herbicides has led to some counterproductive outcomes. The DFFE was found to have been grossly negligent after its WfW employed unqualified contractors who used a toxic herbicide to clear alien vegetation. The North Gauteng High Court ruled that the DFFE was responsible for the contamination of dams on farms in the Alma district in Limpopo. In the ruling, the court found that, "…*the plaintiffs suffered damage as a consequence of wrongful action*…" and that "…*the persistent nature of picloram toxicity implies that* ... *they may continue to suffer damage for an undefined period into the future*.". The court concluded that, "*the Defendant is liable for the Plaintiff's damages, both past and future*". The amount of compensation will be determined in a separate trial. Such cases should be reported where the treatments delivered counter-productive outcomes. [the DFFE has been approached to provide information on other such cases, should they exist]

4.10. High-level indicator: 4. *Level of success in managing invasions*

The level of success in managing invasions is ineffective. Extensive regulations are in place to prevent the entry of new species and to manage those that are here, but the capacity to fund management and ensure compliance with the regulations falls well below what is needed. Research studies have typically reported failures to contain invasions when assessed at wider scales. For half of the known pathways of introduction there is either no management, or management is ineffective or could not be estimated. Control efforts have not managed to stem the spread of invasive plants at a national scale, other than for some of those under biological control.

4.11. Trends in interventions since 2014

[work in progress]

Box 4.1 South Africa's approach to biosecurity

Biosecurity actions taken by South Africa's government have historically been sector-specific, for example, the DFFE worked to prevent the introduction of environmental threats, while the DoA worked to prevent the introduction of agricultural pests. This approach has been the norm globally and was shaped by sector-specific international agreements and their standards and guidelines. However, given the issues, processes, and solutions are often the same across sectors there has been a growing call for a more integrated 'One Biosecurity' approach (Hulme 2020). In South Africa, biosecurity functions related to agriculture, the environment, and Port Health, amongst others, have over recent years been transferred to the Border Management Authority (BMA), which officially commenced operations on 1 April 2023 (Box Figure 4.1). Having these biosecurity functions under a single command enables closer working relations, sharing of information, and the integration of planning and execution of activities. For example, training occurs across the specialities, and all specialities now benefit from risk-based information, allowing for a move away from random selection for inspections.

Several industry specific organisations are heavily involved in South Africa's biosecurity system. For example, Citrus Research International (CRI) is the mandated research and technical service provider to the southern African citrus industry. As part of this work, CRI identifies priority biosecurity threats, conducts pest risk assessments, develops rapid response action plans for these threats, designs and implements early warning detection surveillance, and increases awareness. CRI surveillance activities include coverage of the most likely incursion routes. For example, the surveillance programme for *Diaphorina citri* (Asian citrus psyllid), the vector of Huanglongbing disease of citrus, operates in South Africa and neighbouring countries. CRI does this work in collaboration with the DoA, including through pest specific steering committees – a good example of biosecurity public-private partnerships. Similarly, Hortgro is an organisation that represents South Africa's deciduous fruit industry. At Hortgro, the Crop Protection and the Trade and Markets teams are responsible for identifying biosecurity threats, coordinating surveillance, sharing knowledge with growers, promoting awareness, and developing management plans for threats to the industry. In 2022 *Drosophila suzukii* (spotted-wing drosophila) was detected in South Africa for the first time based on a low-level surveillance project funded by Hortgro (in collaboration with Insect Science). In response to this detection, a multi-industry trapping network for this pest was set up across South Africa and the Monitoring Centre of Excellence at FruitFly Africa was established. The Monitoring Centre coordinates the monitoring and surveillance for *D. suzukii* and *Euwallacea fornicatus* (polyphagous shot-hole borer), but also assists in identifying other high risk pests such as *Bactocera zonata* (peach fruit fly) for which surveillance may be required.

Another biosecurity initiative established in 2016 uses botanical gardens and arboreta as sentinel sites for tree health monitoring. The project—a collaboration between SANBI and the Forestry and Agriculture Biotechnology Institute (FABI)— aims to improve surveillance and identification of tree pests and provide training in biosecurity best practices. The project has played a key role in detecting new invasive species [e.g., *Euwallacea fornicatus* (polyphagous shot borer) in 2017 (Paap et al. 2018)]; and identifying species that pose an increasing threat [e.g., *Dematophora necatrix* (white root rot fungus) recorded on native trees for the first time in surveys undertaken in 2022/2023 (Balocchi et al. 2025)].

Box Figure 4.1. *Eriocheir sinensis* (Chinese mitten crab) intercepted by the BMA at OR Tambo International Airport – Takalani Shakudyiwa.

Box 4.2 Local and volunteer groups involved in invasive plant clearing

Many alien plant control projects are carried out by volunteer groups. The overall contribution of these groups to South Africa's response to biological invasions is yet to be fully quantified, but the evidence is that the contribution is significant. Jubase et al. (2021) identified 52 volunteer groups and estimated that they cleared nearly 5 300 ha of land per year with estimated labour contributions of ZAR 5.1 million. The non-profit organisation Wild Restoration (www.wildrestoration.org) is incubating an action and learning network for local and volunteer groups and community organisations involved in invasive clearing within the Cape Floristic Region. The network's goals include mapping and estimating the impact of these groups and sharing information and practices. Wild Restoration has identified and recruited 100 groups that focus on the greater CFR into its network. It is likely that there are many more groups active across the region and South Africa more widely.

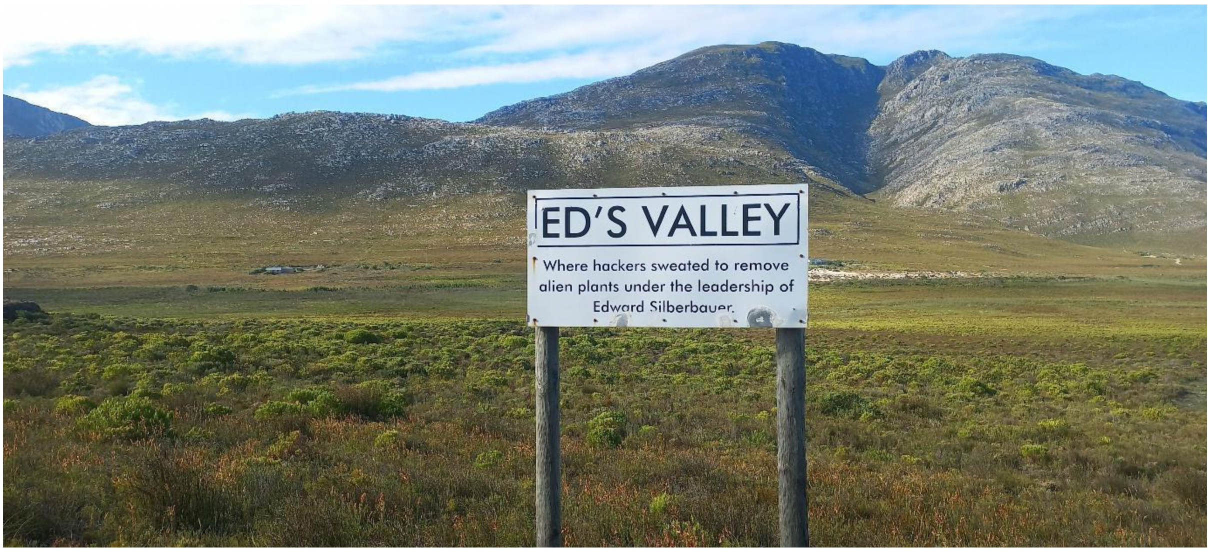
Volunteer groups include: informal hack groups; 'Friends of' and honorary rangers groups supporting nature reserves, river systems, and parks; outdoor sports clubs; student eco-clubs; the Botanical Society of South Africa; citizen science groups; residents and ratepayer's associations; conservancies and private landowners; conservation societies; and specialist clearing non-profit groups. These groups conduct both initial clearing and follow-up in urban and rural areas, with a focus on the dominant invasive plant species in each area. Most use hand pulling and hand tools such as saws, loppers, and poppers, as well as chainsaws and battery-operated saws. Herbicides are frequently used to prevent resprouting. They operate on municipal and private land as well as in protected areas. Some work independently while others have collaborative arrangements with agencies such as South African National Parks, provincial conservation agencies, or municipalities. Most groups are motivated by protecting biodiversity in their local areas. As they are typically active over a long time in the same area, they are also well-placed and motivated to follow up and track ecosystem recovery.

Some clearing groups have been operating consistently for more than three generations, and others have formed more recently. The groups range from small clearing teams of 3 people that operate once a month to teams of 60 volunteers with weekly outings, and organisations with multiple paid crews clearing 5 days a week. Not all are currently able to track activity and impact consistently, but Wild Restoration estimated that over 900 people were involved regularly in 2024, contributing over 20,000 volunteer hours, around 300,000 paid work hours, and clearing over 8,500 hectares.

Although a handful of groups secure some public sector funding for clearing activities (notably via LandCare), the majority are self-funded, with some limited support and in-kind contributions. These sources include local public donations, grants and philanthropic funding, member fees, auctions and fundraising events, ringfenced property levies, and improvement district budgets.

A notable project is the ‘Helihack Initiative’ which is a specialist non-profit organisation that uses helicopters to reach invasive trees in inaccessible areas where they are felled by volunteers that have mountain climbing or tree felling experience. They are primarily funded by private foundations, and partner with local organisations and communities in some of their locations. Cape Nature and the Helihack Initiative recently signed an agreement to clear in inaccessible parts of protected areas.

If biological invasions are to be addressed by a whole of society approach (particularly considering declines in central government funding), it will be important to ensure the contributions of such groups are recognised and appropriately supported.



Box Figure 4.2. A sign erected to recognise the contributions of the late Edward Silberbauer who led a volunteer group that has removed invasive plants from the area in the background over several decades. This group is still very active in the Overberg region of the Western Cape.

5. Monitoring Framework

Lead authors: John R. Wilson, Katelyn T. Faulkner, Masingitla P. Mtileni, Brian W. van Wilgen, Tsungai A. Zengeya

Contributing Authors: Carina Malherbe

5.1. Overview and key findings

The aim of this chapter is to highlight the monitoring that is currently on-going and what is required to better understand and manage biological invasions in South Africa. The different types of information currently available on biological invasions in South Africa are reviewed, noting the strengths and weaknesses of the various approaches to collect data (Section 5.2). Next, based on the theory of change approach, a proposed framework is presented that codifies interventions (Section 5.3). The desired invasion-specific outcomes are specified and, from this starting point, the necessary outputs and inputs are identified. For a theory of change approach to be effective, however, it is essential that progress is monitored. The current system of interventions is reviewed and discussed, and information available and needed is summarised (Section 5.4). Options to mobilise monitoring data so such information is available to decision makers is then discussed (Section 5.5). The chapter closes with an evaluation of integrated governance in South Africa, i.e., how different organisations work or do not work together across scales and disciplines (Section 5.6).

The key findings and gaps are:

- Significant resources have been invested to determine where invasive species are, but these efforts are not well co-ordinated. A systematic review of the information content of databases on South African alien taxa would facilitate the prioritisation of monitoring.
- South Africa has a sophisticated range of processes to address biological invasions. Integrating these processes and databases, and making them transparent, would result in significant gains in efficiency and understanding.
- The development of workflows to ensure data are mobilised would facilitate the prioritisation of future monitoring efforts; similarly, there are important gaps in the flow of information that if filled would allow for interventions to be evaluated.
- A theory of change approach would help to codify what additional monitoring is needed to determine the effectiveness of interventions. Specifically, a focus on invasion-specific outcomes and broader outcomes would assist with planning and reviewing interventions.

- There are currently few effective mechanisms for integrated governance of biological invasions [across scales (including neighbouring countries) and disciplines], noting the draft national strategy on biological invasions promises to address this.

5.2. Different types of survey data and existing sources in South Africa

Various data are collected on alien taxa in South Africa. These data vary in their type, in the methods followed for their collection, in their quality and scope, and in the extent to which they follow the FAIR data principles (Findable, Accessible, Interoperable, Reusable). There are several datasets with occurrence records of alien taxa collected through structured surveys. These include projects where standardised, repeated sampling is done to determine spatio-temporal trends (e.g., Kalwij et al. 2015), and once-off surveys of areas to estimate distribution and abundance (e.g., Cheney et al. 2018). These datasets can provide high quality data that can be used to estimate status and track trends, but are generally set up to answer specific research questions, cover small parts of the country (e.g., a part of a protected area), and the data are often not widely available. The last review of South African lists of alien taxa and their information content was over a decade ago (Faulkner et al. 2015; see also Robertson et al. 2010 for a discussion on atlas data with South African examples). The following is a brief review of the situation, noting that an updated and systematic review of data sources would facilitate the prioritisation of monitoring efforts.

Several, long-term national or regional atlas projects exist, with these projects either including data on alien species [e.g., Southern African Bird Atlas Programme 2 (SABAP2; https://sabap2.birdmap.africa/)] or are dedicated to the collection of data on aliens [the Southern African Plant Invaders Atlas (SAPIA)]. These datasets provide good quality data on the distributions of species as they follow pre-defined survey methodologies with surveys either performed by experts (e.g., SAPIA), or with the records undergoing a quality check (e.g., SABAP2). However, these surveys are not systematically repeated over time and are often spatially biased (Brooks et al. 2022). Survey effort data for SABAP2 and SAPIA are available, and notably there are some examples of sub-projects where surveys are systematically repeated [e.g., SABAP2's Hessequa systematic atlassing Subproject; see van Rooyen (2018), and van Rooyen and Underhill (2020)]. However, these projects vary in how and when data are made available. For example, SABAP2 data are uploaded every two weeks to the Global Biodiversity Information Facility (GBIF) (Brooks and Ryan 2023), but are also made available through the website for the project (https://sabap2.birdmap.africa/) and using the R package rabm (https://github.com/davidclarance/rabm). In contrast, SAPIA data are currently only available on request.

Table 5.1 Different atlas projects in South Africa

Name	Focus	Sampling strategy	Duration	Status	Reference
Southern African Plant Invaders Atlas	Invasive plants outside of cultivation	Road-side in different areas of the country, additional submission by observers	1974–2021	Finished	Henderson (2007)
Southern African Bird Atlas Programme 2	Birds	BirdMap protocol conducted by citizen scientists	2007–current	On-going	Brooks et al. (2022)
South African National Survey of Arachnida	Arachnida	Standardised surveys in selected areas (mainly in Savanna and Grassland Biomes)	2008–2011	Finished	Dippenaar-Schoeman et al. (2015)
Southern African Butterfly Conservation Assessment (SABCA/LepiMAP)	Lepidoptera	Citizen science and expert input	2007 - current	On-going	www.lepsocafrica.org/?p=projects&s=sabca
Atlas of Southern African Freshwater Fishes	Freshwater fishes	Citizen science	2006 - current	Ongoing	Scott et al. (2006)
Frog Atlas of Southern Africa (FrogMAP)	Amphibians	Citizen science	2004 – current	Ongoing	Minter et al. (2004)
Atlas for dragonflies and damselflies in Africa (OdonataMAP)	Odonata	Citizen science	2010	Ongoing	Dijkstra (2016)
Protea Atlas Project	Proteas	Citizen science	1991-2001	Finished	Rebelo (1993)

Ad hoc records of alien species are collected through a wide range of initiatives; these include citizen science platforms like iNaturalist, collections of museum specimens, and barcoding projects. The digitisation of historical records and mobilisation of these data through platforms such as GBIF have made large amounts of these data readily available [for example, the Southern African Reptile Conservation Assessment (Bates et al. 2014) and Freshwater Biodiversity Information System (Dallas et al. 2022)]. However, these data often contain errors and are biased, and thus the extent to which the patterns they demonstrate reflect reality is unclear.

An increasing number of studies have shown the potential for remote sensing to contribute to monitoring biological invasions (cf. Boxes 3.1, 3.2). As for atlas projects, it is important for such information to feed through to relevant databases and scoring indicators.

Data on alien species can also be collected through initiatives for which such data is not the primary goal. For example, Google Street View archives have been shown to be a potentially useful tool in mapping and monitoring spread through historical images, e.g., to assess alien plant population changes (Adams 2024) and to trace the invasion of *Euwallacea fornicatus* (polyphagous shot hole borer, PSHB) in Johannesburg (PSHB appears to have been present since at least 2017; Mudede et al. 2025). Similarly, the marine bryozoan *Amathia verticillata* was first recorded in South Africa from Langebaan Lagoon Marine Protected Area (MPA) in 2023, but images of birds taken in the area and uploaded to iNaturalist suggest that *A. verticillata* was present in the lagoon since at least 2021 (Ackland et al. 2025).

The various types of data collected have their strengths and limitations, and thus it is important to use data from a range of sources and techniques. However, actions should be taken to understand and improve data quality where possible, and, when survey effort data are available, corrections or estimates that consider survey effort should be derived [e.g., by estimating sample completeness (see Chao et al. 2020)].

[Note to reader: once completed, a link to the issues identified in Chapter 6: Gaps will be made here]

5.3. Unified framework for management

Various frameworks have been developed for biological invasions that have been highly influential or at least highly cited (Wilson et al. 2020a, b). There are also very useful frameworks for specific management challenges [e.g., to track progress towards eradication (reviewed by Wilson et al. 2017)]. For example, the invasion curve is an excellent communication tool to demonstrate the relative cost of interventions at different stages (e.g., Victorian Government 2010). And important guiding documents exist for the various activities involved in the management of biological invasions (e.g., a toolkit has been developed to assist countries in meeting Target 6 of the Kunming-Montreal Global Biodiversity Framework; CBD and IUCN 2024). But despite the conceptual appeal, attempts to map interventions onto the unified framework of biological invasions of Blackburn et al. (2011) have not provided useful tools. For example, specifying particular goals for particular invasion stages (e.g., Robertson et al. 2020) produces appealing graphics, but in practice there are too many exceptions—the management context matters. For example, containment can be important for widespread invasions [e.g., preventing *Phytophthora* spp. from spreading from infested sites through biosecurity measures (Liew et al. 2023)]; and while eradication is possible for some widespread taxa [e.g., smallpox (Fenner et al. 1988)], in other cases (particularly in marine settings) attempting to eradicate even limited incursions can be too costly and unlikely to succeed (Katsanevakis et al. 2023; IPES, 2024).

One approach to more clearly articulate interventions is that of the theory of change (https://www.theoryofchange.org/what-is-theory-of-change/). The basic idea is that by being explicit about the goals in terms of impacts on biological invasions (i.e., invasion-specific outcomes), it is easier to clearly specify the necessary outputs, the activities needed to achieve the outputs, and therefore the required inputs (see example in Figure 5.1). For each component, indicators are proposed and assumptions specified (though not shown on Figure 5.1). Aligning the indicators with the indicator framework used in this report (Figure 0.2) will facilitate reporting [to address this, the indicator factsheets have been updated to link to the theory of change approach (Appendix 1)]. A theory of change framework for biological invasion interventions also: 1) separates the inputs and the activities required to achieve particular outputs; and 2) identifies general societal outcomes that the invasion-specific goals are feeding into. Importantly, while such an approach can be provided for managing biological invasions in general, it can also be used to define which interventions are needed rather than starting with an intervention and working out which goals it might achieve.

To ensure that management is strategic and adaptive, there also needs to be a structured process of scoping, implementation, and assessment. During the assessment stage, if the activities are not resulting in the desired outputs, a change might be needed to the inputs. Activities can either be continued or revised, new activities proposed, and, if little progress is being made, it might be appropriate to develop more realistic outputs and outcomes. See Strydom et al. (2023) for an example of applying strategic adaptive management principles to the use of fire to reduce woody plant encroachment.

The theory of change thus provides a framework for identifying necessary and sufficient interventions and what needs to be done to monitor progress. The approach has potential to inform the structure and implementation of planning at different scales, e.g., South Africa's national strategy on biological invasions; objectives and actions for private land-owners; and pathway action plans for state entities.

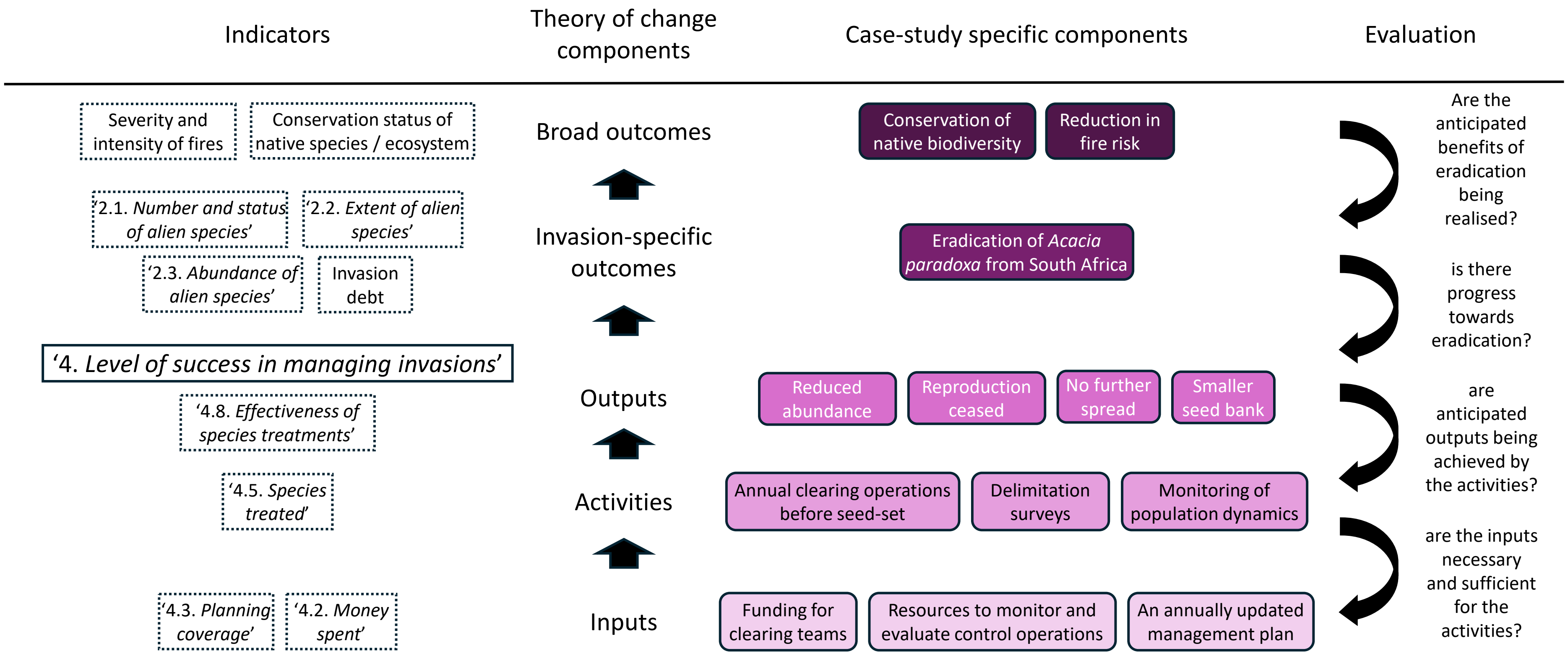


Figure 5.1 An example of the theory of change approach applied to the goal of eradicating *Acacia paradoxa* from South Africa. *Acacia paradoxa* is only known from the northern slopes of Table Mountain in Cape Town. An attempt at eradication began in 2007 (Zenni et al. 2009; Moore et al. 2011) and is on-going. The plan is to ensure annual search-and-destroy surveys are conducted every year in flowering season (i.e., before seed-set so reproduction can be prevented but while flowers are present to increase detectability). The starting point is the invasion-specific outcome from which the other components are created. Progress is intended to be evaluated annually with the management plan adapted depending on the situation (e.g., any fire in the area should trigger intense control operation in the following year as fire will stimulate the germination of soil-stored seed-banks). The numbered indicators are from the indicator framework used in this report (Figure 0.1).

5.4. Monitoring effectiveness of interventions

The lack of monitoring of the effectiveness of interventions to address biological invasions has been highlighted as a significant gap in all reports to date. In South Africa, management effectiveness is rarely, if ever, monitored (cf. Chapter 4). A process is needed to ensure infield observations of what works feeds through into best practice guidelines and facilitates adaptive management. The collection of essential data is critical to enable progress to be tracked. Crucially this cannot happen if monitoring is not appreciated and funded as an essential part of control operations. This report is mandated to address very specific elements by the A&IS Regulations (See Section 0.1.2), but the overall system is much broader, and information is collected of many different types. To score the overall indicator '4. *Level of success in managing invasions*', the overall system needs to be understood and the corresponding information available. This is unpacked here by exploring different components of the system in series of flow diagrams (Figure 5.2), with the resulting information available and needed summarised (Table 5.3).

Figure 5.2 Flow diagrams (A–J) outlining interventions to address biological invasions. The diagrams are idealised and simplified. Links to greater detail are provided if available, with the resulting information requirements and outputs highlight in italics in the figure legends and shown in Table 5.3. Inputs are the starting points for these diagrams and end points are concluding decisions or declarations. The diagrams can, in some cases, flow into each other, but each diagram is intended to be read on its own. Please note these diagrams are interpretations of the situation and have no legal basis.

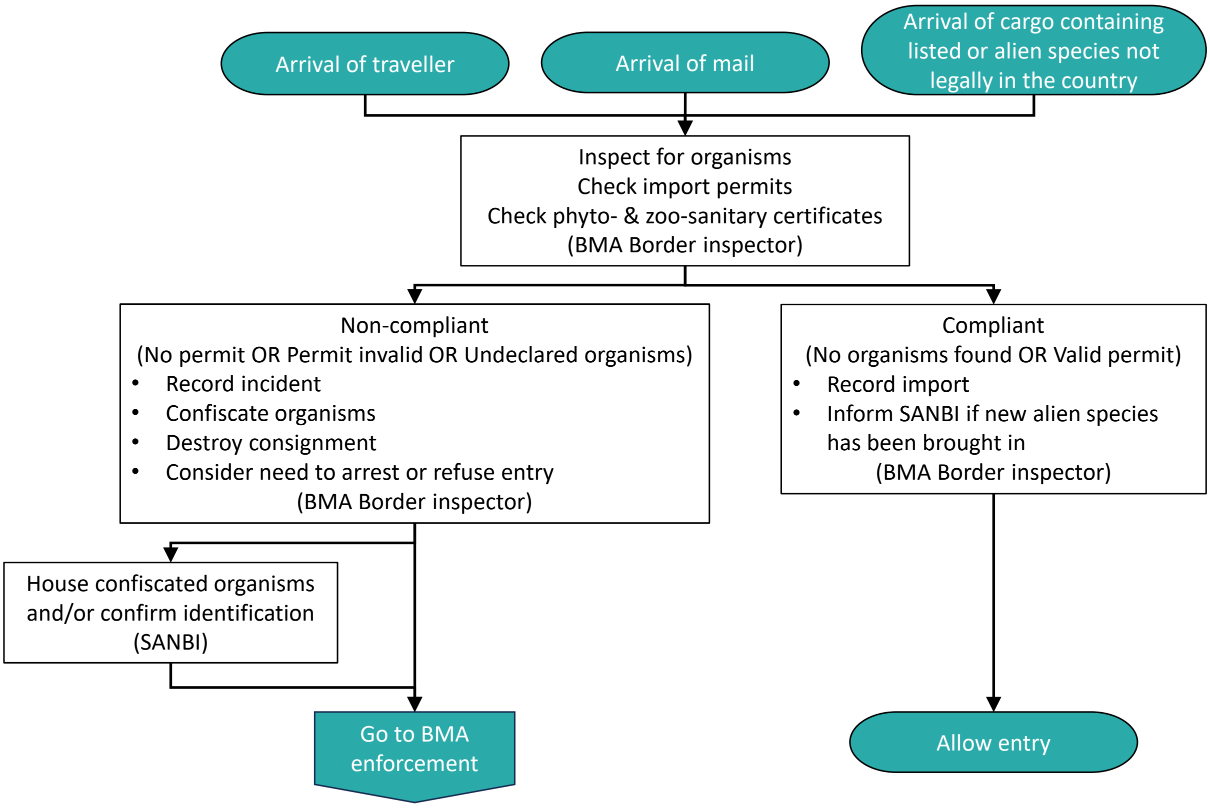


Figure 5.2 [Cont.] A) At-border inspections to identify environmental threats. The process for BMA enforcement has not been codified here, for the process of enforcement used by DFFE that may share some similar features see Fig. 5J. The process requires access to the *Permit database* (to cross-check import permits) as well as a *List of alien taxa that do not require a risk analysis for importation*. The process should add to the *Database of at-border biosecurity interceptions* and potentially the *List of alien taxa in South Africa* and the *Prosecution database*.

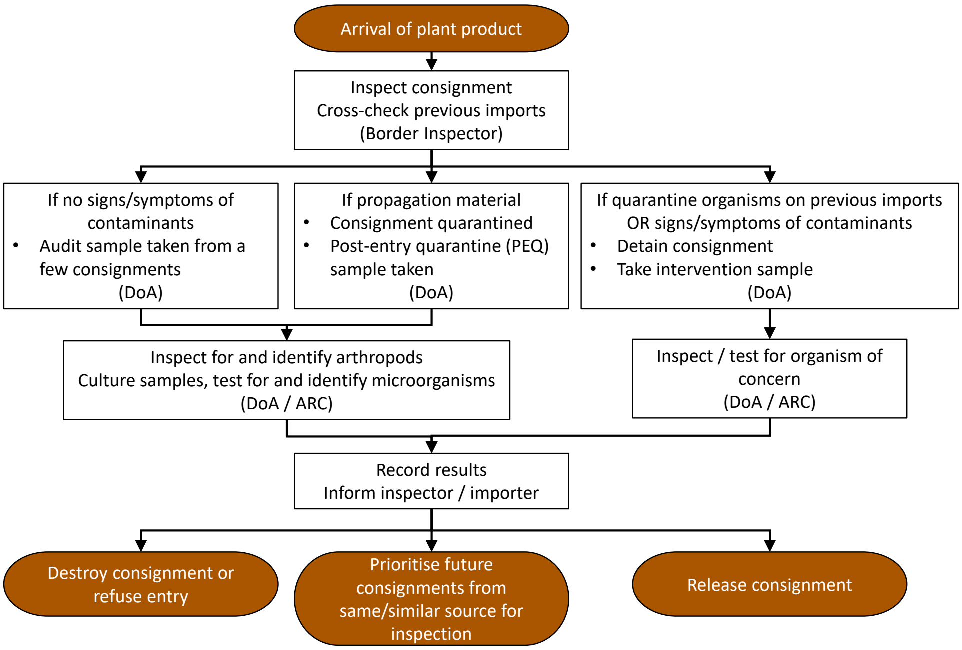


Figure 5.2 [Cont.] B) The at-border biosecurity process for evaluating plant products for the risk of contaminants [adapted from Saccaggi et al. (2021)]. The process requires access to and should add to the *Interceptions on plant product imports* (noting there is a separate process for additions to the *Database of at-border biosecurity interceptions*). Interceptions of contaminants of plant products are not currently added to the *List of alien taxa in South Africa* as the interception of a taxa at-border does not imply that live individuals or propagules of the taxon are found post-border; though they clearly represent an important part of the invasion debt.

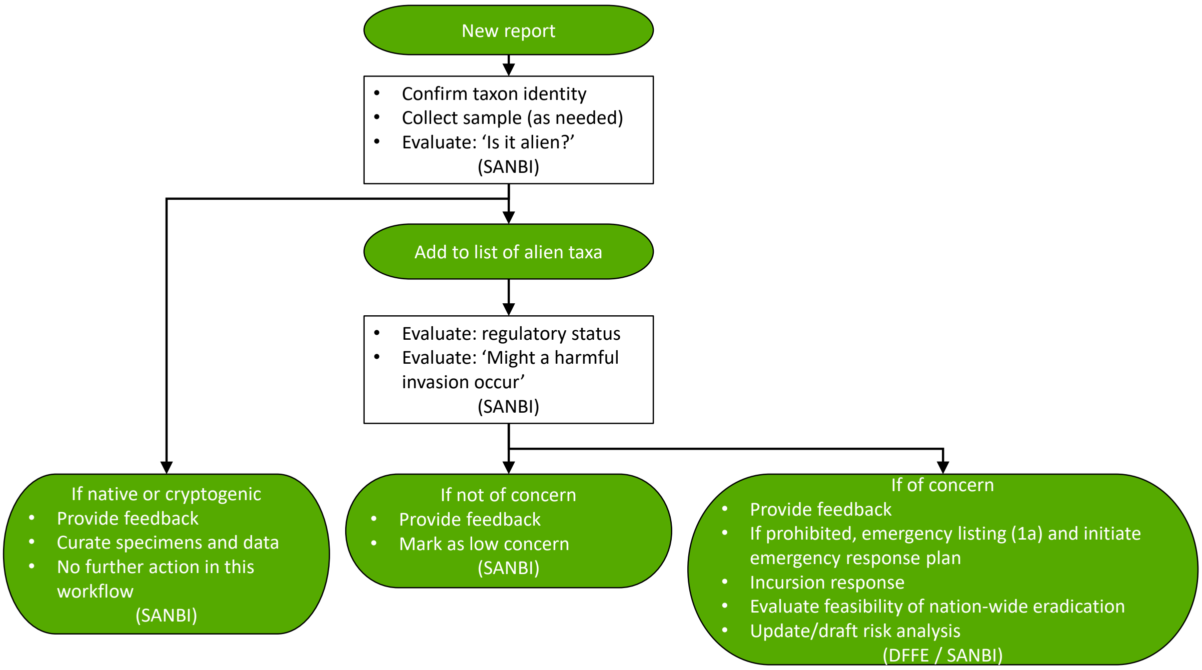


Figure 5.2 [Cont.] C) The process to deal with new incursions. The intention is for a new report to always be published, this might happen at different points in this flow diagram, and a publication might actually be the new report itself. Updated from Wilson et al. (2013). The process requires access to and should add to the *List of alien taxa in South Africa* and may add to the *SUSPECT list* and potentially the *NEM:BA A&IS Lists* (in the case of emergency listings).

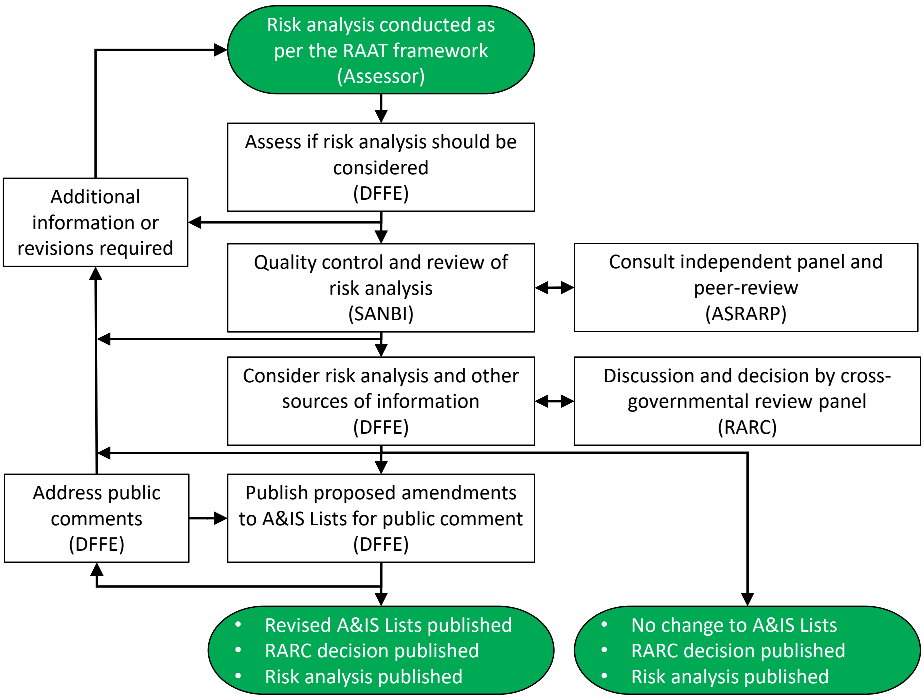


Figure 5.2 [Cont.] D) The process for listing taxa under the A&IS Regulations. There are a few additional processes not shown here for simplicity, e.g., direct loops between DFFE and SANBI in terms of evaluating risk analyses. ASRARP is the Alien Species Risk Analysis Review Panel; RAAT is the Risk Analysis for Alien Taxa framework; and RARC is the Risk Analysis Review Committee. For full details of these processes see Supplementary material 1 of Wilson and Kumschick (2024). The process requires access to and may result in changes to the *List of alien taxa in South Africa*, the *List of taxa subjected to a risk analysis*, the *SUSPECT list*, and the *NEM:BA A&IS Lists*

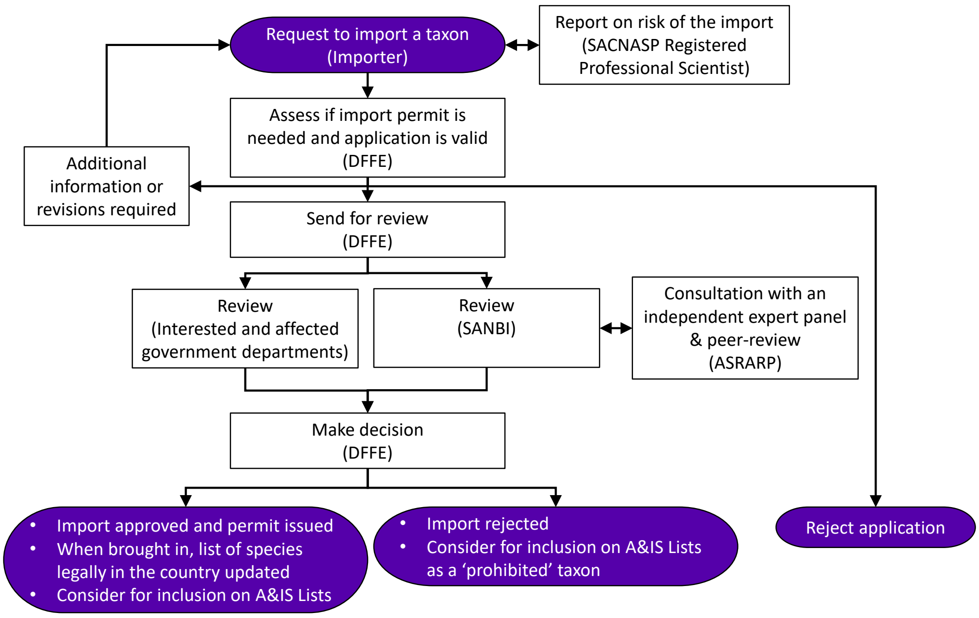


Figure 5.2 [Cont.] E) The process to import an alien taxon. See legend to panel D for acronyms, and Supplementary material 1 of Wilson and Kumschick (2024) for full details of these processes. The process requires access to the *List of alien taxa that do not require a risk analysis for importation*. The process may add to the *List of alien taxa in South Africa* and the *NEM:BA A&IS Lists* as well as the *List of taxa subjected to a risk analysis*. The process will add to the *Permit database*.

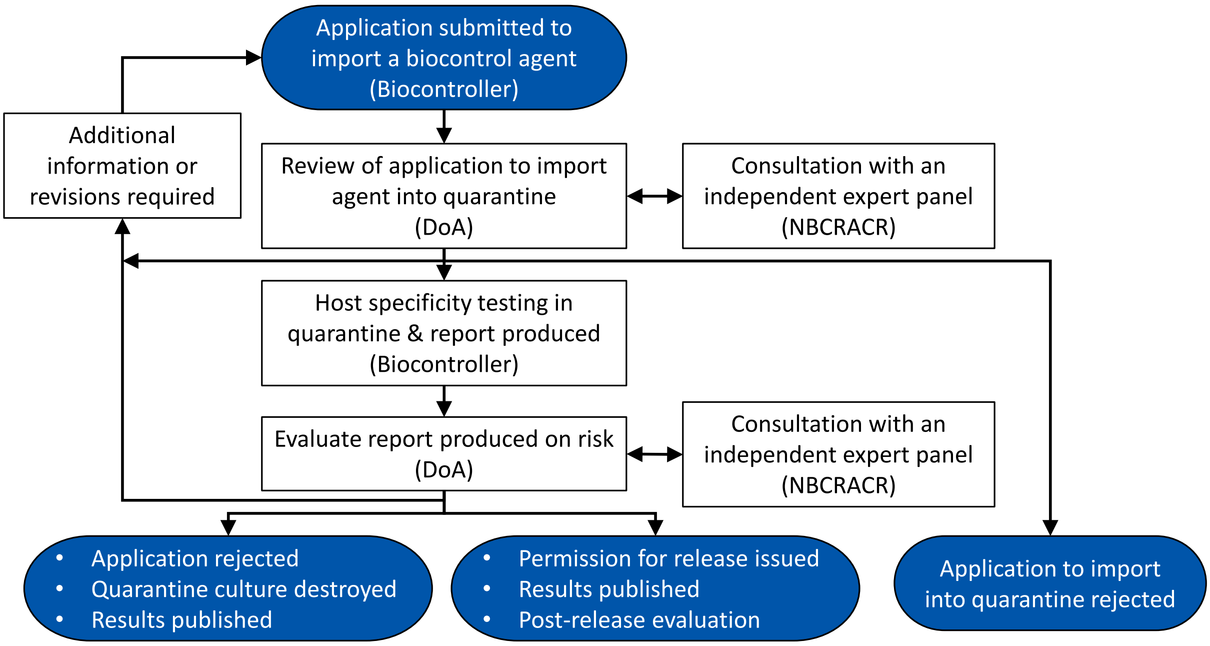


Figure 5.2 [Cont.] F) The process to import and release a classical biological control agent (adapted from Ivey et al. 2021). NBCRACR: National Biological Control Release Application Review Committee; DoA is the Department of Agriculture. The decision by the biocontroller might be to not submit a report on risk for formal consideration (as the host specificity testing conclusively demonstrates an unacceptable risk). Nonetheless the project should still be written up and recorded both for posterity and for international collaborators. The process should add to the *Biological control agents and their statuses* and the *List of alien taxa in South Africa*. Note the permit issues here are not currently incorporated into the *Permit database* mentioned in Table 5.3.

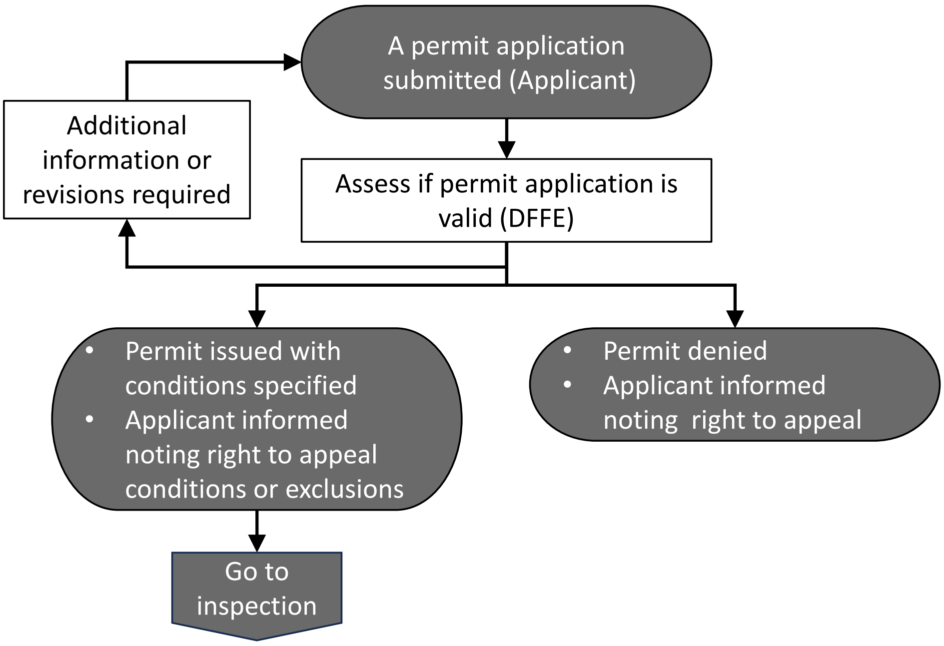


Figure 5.2 [Cont.] G) Applications for permits to conduct activities on taxa listed under the A&IS Regulations. The relevant part of the DFFE is the Issuing Authority / Permits Office. As part of assessing the validity of a permit there may need to be consultation with the provinces and an inspection of facilities (pre-permit inspections). On issuing a permit the information is captured in the permit database and sent to the DFFE Biosecurity Compliance. The process requires access to the *NEM:BA A&IS Lists* and will result in additions to the *Permit database*.

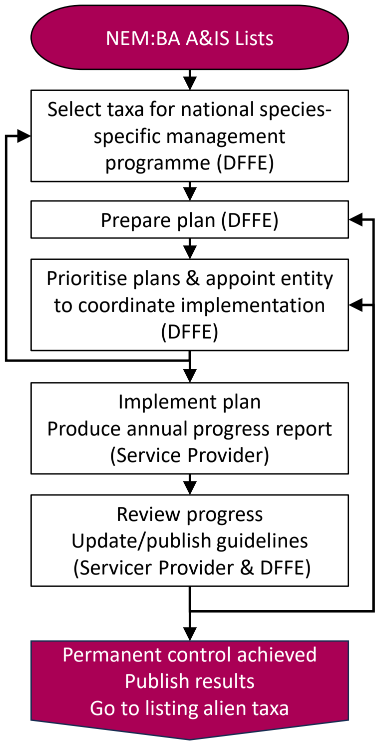


Figure 5.2 [Cont.] H) The development and implementation of management plans for species. The process requires access to the *NEM:BA A&IS Lists* and will add to the *Database of species-specific management plans*. The entities that coordinate implementation were historical called 'Implementing Agents' but the term 'Service Provider' is now preferred; service providers include a wide range of governmental and non-governmental institutions.

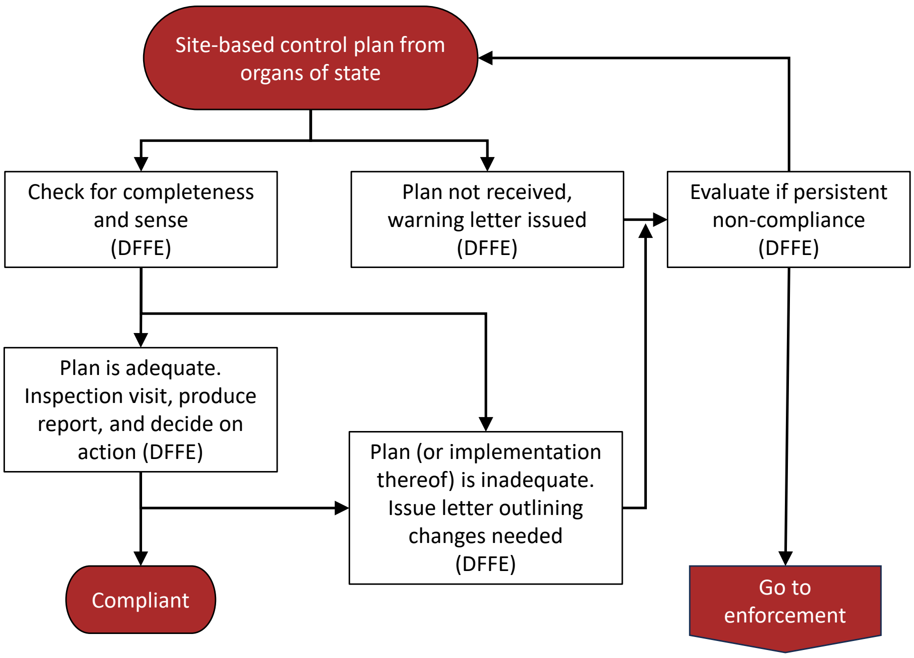


Figure 5.2 [Cont.] I) The development and implementation of management plans for sites. The process requires access to the *List of organs of state that require site-based control plans* and will add to or update the *Database of site-based control plans*. The process will also produce *Report on progress with the implementation of control plans*.

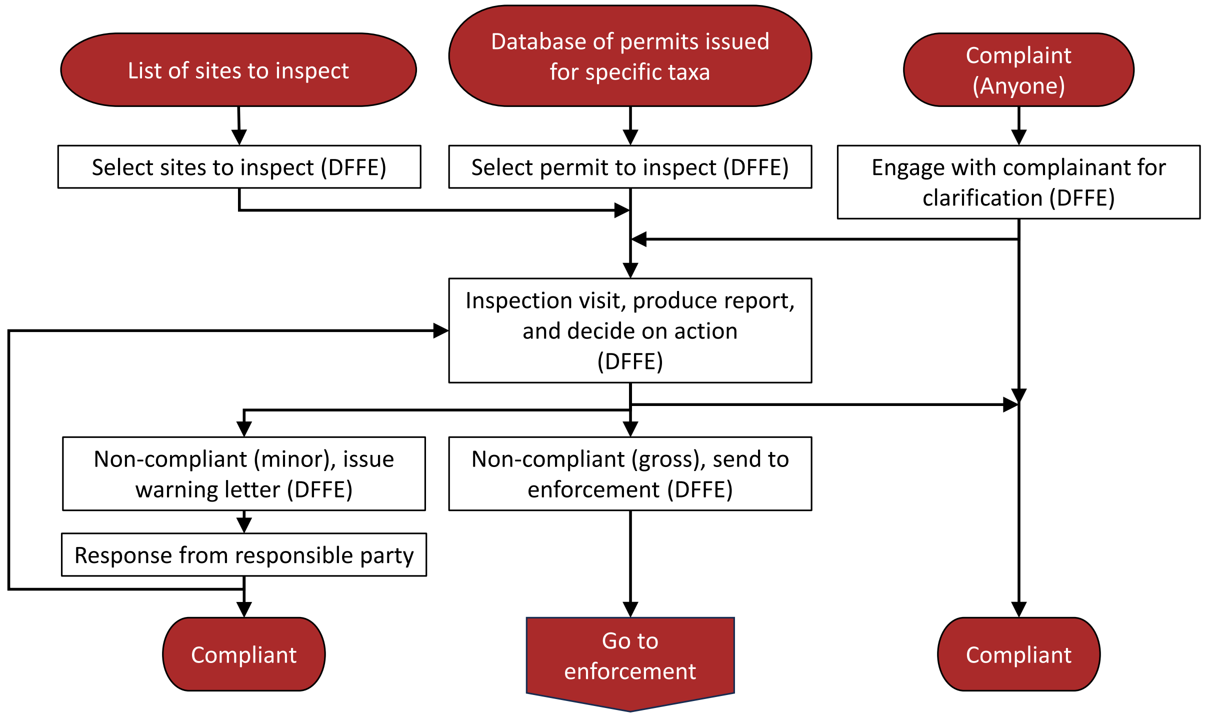


Figure 5.2 [Cont.] J) inspections to assess compliance with the A&IS Regulations. Inspection workflows and the following enforcement workflow can only end with compliance, noting decisions on compliance are made by the DFFE Compliance, the DFFE Enforcement, the National Prosecuting Authority (NPA), and the courts. When a complaint is received it is loaded onto the Environmental Crimes Electronic Case Management System (ECAS), only a part of this is relevant to biological invasions. Complaints should be made via the environmental crimes hot-line [or can be directed to an Environmental Management Inspector (EMI) of a relevant environmental management entity (though this may delay the process as the official will then be required to refer the matter for uploading on ECAS)]. The process of deciding on the level of non-compliance needs to be codified. Environmental Management Inspectors deal directly with the regulated community and have the power to issue lawful instructions. The process requires access to the *Sites that require inspection* and will result in additions to the *Inspection database* and *Electronic case (ECAS) management system*.

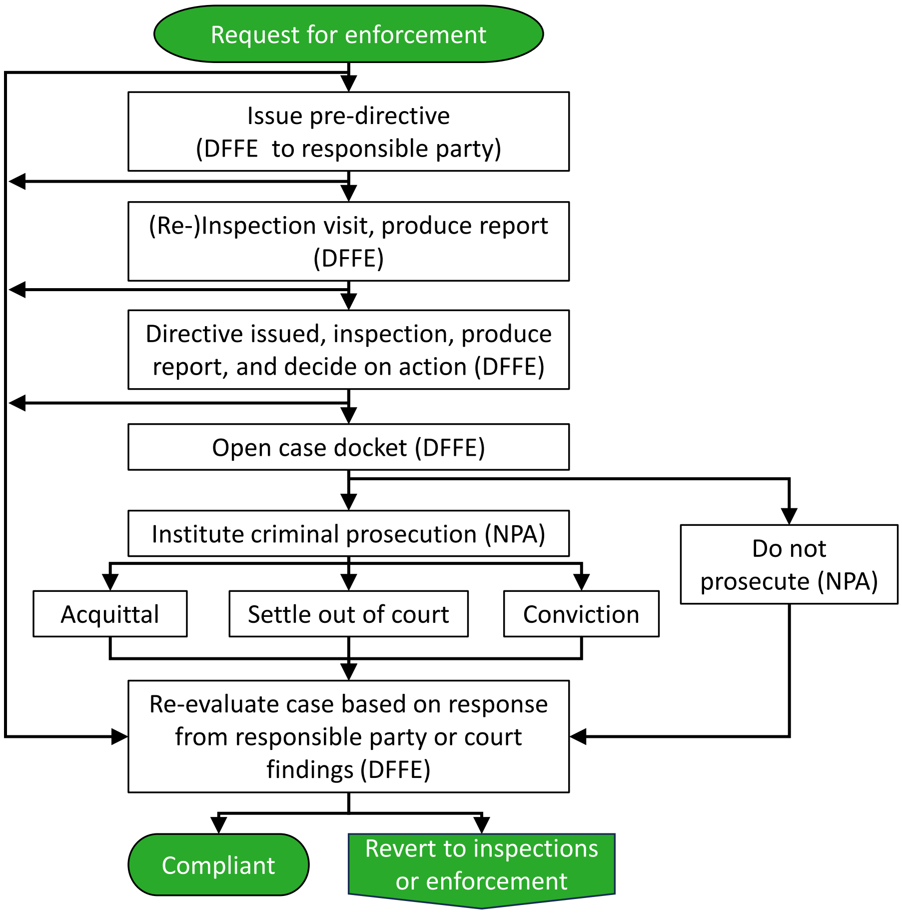


Figure 5.2 [Cont.] K) Enforcement activities regarding the A&IS Regulations. The initial processes can be run by any of the EMI entities[24], noting that the responsibility to inspect permits for compliance resides with the permit issuing authority; for the A&IS Lists that is DFFE (as shown here). Once a case docket has been opened the process is handed over to the NPA (the National Prosecuting Authority) and potentially the courts. In emergency situations the issuing of a pre-directive might not be appropriate, but in doing so it should be clear why corrective measures could not be put in place (with the decision potentially challenged in court). The process requires access to the *Electronic case (ECAS) management system* will add to the *Prosecution database*.

[24]The DFFE, the Department of Water and Sanitation (DWS), the Department of Mineral Resources and Energy (DMRE), Provincial environmental departments, some local municipalities, and specific organs of state including Ezemvelo KZN Wildlife, Mpumalanga Tourism and Parks Agency (MTPA), Cape Nature, Eastern Cape Parks & Tourism Agency (ECPTA), iSimangaliso, and SANParks.

Table 5.3 Information sources that facilitate or are needed to facilitate how biological invasions are addressed in South Africa under national regulations (cf. Figure 5.2). While these information sources are necessary to score the indicator: '4. *Level of success in managing invasions*' several other sources of information are also required (particularly regarding pathways). Several of these information sources do not currently exist, but are implied that they should exist based on the workflows or are needed for decisions to be made (Figure 5.2). The order of rows in the table reflects the order in which documents are mentioned in the legends to Figure 5.2.

Information	**Description**	**Status**	**Issues**	**Relevant indicators**	**Links and references**
Database of at-border biosecurity interceptions	A list of at-border interceptions	Does not currently exist	Identification can be challenging	4.7. *Effectiveness of pathway treatments*	None
Interceptions on plant product imports	Information on imported plant products inspected by DoA laboratories between 1994 and 2019 and the contaminant organisms found on them	Database 1994–2019 published	No workflow to update published publicly available data base	4.7. *Effectiveness of pathway treatments*	(Saccaggi et al. 2021)
List of alien taxa in South Africa	A list of taxa for which there is evidence that they are present in and alien to South Africa The list includes some other taxa as it is required to by the A& IS Regulations (cf. Section 0.1.2). If a taxon is recorded as absent on this list, then it is likely a permit will be required to import it (noting this list has no formal legal status)	List has been created	Many sources not yet incorporated, particularly taxa in cultivation	2.1. *Number and status of alien species* [and many others in the ancillary data]	Appendix 6 (Fernández Winzer et al. 2025b; Zengeya et al. 2025, in press)

Information	Description	Status	Issues	Relevant indicators	Links and references
List of alien taxa that do not require a risk analysis for importation	This has been described as a list of taxa that are legally in the country The purpose is to determine whether an import permit is required under A&IS Regulation 16. As per clause 16.4, alien taxa which were introduced to South Africa prior to 30 March 2016 need less detail for an import permit to be issued	No such list exists Decisions on the requirement for an import permit have, to date, been made on a case-by-case basis	Permits may also be required at the provincial level to introduce an alien taxon Historical data on imports and permits are not curated, mostly not digitised, and stored in several places (e.g., in provincial offices) Listing might be at species level but import at subspecific level There are no guidelines on what is necessary and sufficient evidence that a taxon has been legally introduced	1. *Rate of unregulated introduction of new species* 4.1. *Quality of regulatory framework*	For discussion of the need for such a list see Wilson and Kumschick (2024)
SUSPECT list	A list of unregulated alien taxa that have been recorded as present in South Africa for which there is concern that a harmful invasion might occur (or be occurring) This list has no legislative status. The intention is that taxon are moved off the SUSPECT list following the completion of a risk analysis, and so a decision can be made to either regulate or not	No current valid version: under redevelopment	Need to finalise a process to add taxon to the SUSPECT list and set a goal and processes so no taxon is on the SUSPECT list for longer than 10 years	4.1. *Quality of regulatory framework*	For previous process see Wilson et al. (2013)

Information	Description	Status	Issues	Relevant indicators	Links and references
NEM:BA A&IS Lists	Regulatory lists	560 taxa listed	Last update came into effect in March 2021 The nomenclature of several of the taxa are outdated Regulatory lists are not tidy Currently no prohibited list	4.1. *Quality of regulatory framework*	(Wilson 2025; Wilson and Kumschick 2024)
List of taxa subjected to a risk analysis	A list of risk analyses completed for taxa alien to South Africa in support of the A&IS Regulations. Each risk analysis is an evaluation of the likelihood and consequence of an alien taxon becoming invasive in South Africa with a recommendation for regulation in the context of the available options to effectively manage risk whilst retaining any benefits. Risk analyses are produced as per the Risk Analysis for Alien Taxa (RAAT) framework. They result in a recommendation for listing (or not listing). The intention is for all taxa listed under the A&IS Regulations to have a risk analysis conducted on them	As of the end of 2025, 148 (26%) of taxa listed under the A&IS Regulations have a risk analysis. ~40 of these risk analyses have been considered by the RARC. None of these have been published The RAAT framework v1.0 was published in 2017, with the last update (v2.0) published 2025	Risk analyses are not currently in the public domain The process to deal with cases in which the decisions of the RARC does not align with recommendations of ASRARP has not been implemented to date As the regulatory lists were created before the development of the RAAT framework, most listed taxa still do not have a risk analysis	4.1. *Quality of regulatory framework*	Table S4.1 (Kumschick et al. 2025; Wilson and Kumschick 2024)

Information	Description	Status	Issues	Relevant indicators	Links and references
Biological control agents and their statuses	Which biological control agents have been considered and tested against which targets There are separate databases for biocontrol agents targeting plants and invertebrates	Much of the information is incorporated into the list of alien taxa (Appendix 6) though there are delays in data being copied across	Some agents have not been formally described so do not have a scientific name	1.2. *Introduction rates* 2.1. *Number and status of alien species* 4.8. *Effectiveness of species treatments*	Targeting plants: Zachariades (2021) Targeting invertebrates: Pretorius (2008)
Permit database	A list of permits that have been issued by DFFE to allow permit holders to conduct otherwise prohibited activities with taxa listed under the A&IS Regulations. This forms the basis for determining inspection activities to evaluate compliance with permits. The database also includes information on permits which have been applied for but denied and the reasons for the permit not being issued	As of the end of December 2022, 2906 permits have been issued for 267 valid taxa A tidy version of the permit database with each row being a specific permit for a specific taxon is in the public domain as part of this report cycle [information was provided by the DFFE, but these data are still to be processed and the file updated to the end Dec 2025]	It is not currently clear whether the provisions for any specific permit is being used (e.g., whether a taxon has been imported) The number of instances where a permit is required but has not been issued or applied for has not been estimated A process is needed to prioritise which permits should be inspected	1.2. *Introduction rates* 4.1. *Quality of regulatory framework* with insights to 4.8. *Effectiveness of species treatments*	Section 4.1.4 Appendix 9 (SANBI 2023)
Database of species-specific management plans	This database includes details of the plans and their evaluation	No species-specific management plans have been approved	If plans were approved, a process of regular updates and reporting on progress would also be needed	4.3. *Planning coverage* (for species)	None

Information	Description	Status	Issues	Relevant indicators	Links and references
List of organs of state that require site-based control plans	All organs of state must compile a site-based control plan addressing biological invasions This list would provide an indication of which organs of state require a plan, whether a plan has been developed, and an evaluation of the adequacy of the plan	It is unclear if an official list exists	It is unclear at which scale plans are needed	4.3. *Planning coverage* (for sites)	None
Database of site-based control plans	This database includes details of the plans	Database currently held by DFFE	Area covered by plan, and start and end dates not included in the database	4.3. *Planning coverage* (for sites)	None
Report on progress with the implementation of control plans	Reports on the efficacy of control and eradication measures in line with indicators in the plans	Not currently incorporated into this report	The inclusion of a standard set of indicators is needed	4.9. *Effectiveness of site treatments*	None
Sites that require inspection	Sites that should be subject to inspections for alien taxa of concern, to ensure appropriate measures are in place to limit invasions, and that the A&IS Regulations are being adhered to. A list of sites might be developed based on pathway action plans, species-specific management plans, or through identifying sites that have a high likelihood of harbouring alien taxa	There is no structured process for identifying sites	A process is needed to prioritise which sites are inspected	4.6. *Sites treated* 4.9. *Effectiveness of site treatments*	None
Inspection database	Information on inspections by the DFFE regarding compliance to the A&IS Regulations, including links to report on inspection visits Note this is separate from at-border inspections	Not currently incorporated into this report A new system to track inspections has been developed and information is to feed into future reports	Historical data were either not captured electronically or were not tidy. Significant work is needed to determine past efforts	4.3. *Planning coverage* 4.4. *Pathways treated* 4.6. *Sites treated*	None

Information	Description	Status	Issues	Relevant indicators	Links and references
Electronic case (ECAS) management system	Information on all complaints received through the environmental crime hotline, inspection and outcome of the matter Information on compliance to selected permits, permit conditions following inspection and subsequent compliance processes Note the ECAS contains information on other environmental issues not just regarding alien taxa	Not currently incorporated into this report	Need to establish protocols to determine which information must be redacted to comply with data protection rules and to respect privacy	4.7. *Effectiveness of pathway treatments* 4.8. *Effectiveness of species treatments*	None
Prosecution database	A list of cases that were sent to the National Prosecuting Authority (NPA) with the current status of the case and the outcome as appropriate (acquittal, settle out of court, conviction, do not prosecute)	Awaiting feedback from the DFFE, noting provincial environmental departments will also need to be approached as they can and have instituted prosecutions independently of the DFFE	Inclusion of on-going cases might not be possible	4.1. *Quality of regulatory framework*	None

5.5. Mobilising monitoring data

Monitoring data can inform indicators to track trends for national and international reporting, but the process is not always straightforward. An integration of data from different sources and techniques is important to ensure a wide coverage of monitoring data over time, for different taxa, noting that there is often a lag from when data are collected to when they are made accessible to inform indicators on biodiversity status and change. It is important for data to feed through to local and global databases to facilitate the mobilisation of monitoring data and to inform indicators as required, while accounting for sampling bias, uncertainty in the data, and including data quality filters. For example, data on alien species introductions need to be regularly updated to inform the indicator '*Introduction rates'* as required for the reporting on the status of biological invasions in South Africa and to calculate related indicators to measure progress towards meeting Target 6 of the Global Biodiversity Framework (CBD 2022), however, there are often significant delays (Section 1.5). Regularly updated data from atlas projects or distribution surveys are also needed to inform the indicator '*Extent of alien species*'.

The Global Biodiversity Information Facility (GBIF; https://www.gbif.org) has over 3 billion occurrence records from different sources, including data from peer-reviewed publications and citizen scientists, providing an invaluable platform for the mobilisation of monitoring data. Data from GBIF can be accessible on demand in a standardised and reproducible way through services offered by the Biodiversity Building Blocks for policy (B-Cubed) project– an important step for mobilising monitoring data in an analysis-ready format (https://b-cubed.eu; Groom et al. 2025) Ensuring that all monitoring data feed through to local databases and are integrated into GBIF data on a regular basis will be crucial for such data to be effectively mobilised, and for trends to be tracked.

It is widely recognised that raw biodiversity observations often need careful interpretation for them to be useful for policy makers. Specifically models and corrections are often necessary to convert data into variables and ultimately into information in the form of indicators (Jetz et al. 2019). This report largely reports collated biodiversity observations. The next step will be to provide useful extrapolations or predictions from these. For example, sampling effort must be considered if the indicator '1. *Rate of unregulated introduction of new species*' is to inform reporting to Target 6 via the indicator '*Rate of invasive alien species establishment*' (Section S5.1; McGeoch et al. 2023). Survey effort can also be considered get predicted estimates for '3.1 *Alien species richness*' (Chao et al. 2020). Moreover, "*a globally coordinated approach is needed for biodiversity monitoring*" (Schmeller et al. 2015), this need for integration is discussion in the next section.

5.6. Integrated governance across sectors and scales

The need for integrated governance was the key recommendation of the IPBES IAS Assessment to improve how biological invasions are managed globally (IPBES, 2023). From the IPBES IAS Assessment integrated governance requires efforts to:

1. Enhance coordination and collaboration across international and regional mechanisms;
2. Develop and adopt effective and achievable national implementation strategies;
3. Shared efforts and commitments, and understanding of the specific roles of all actors;
4. Improve policy coherence;
5. Engage broadly across governmental sectors, industry, the scientific community, Indigenous Peoples and local communities and the wider public;
6. Support, fund and mobilize resources for innovation, research and environmentally sound technology; and
7. Support information systems, infrastructures and data sharing.

The proposed strategic actions are enabled when the system-wide properties of governance are:

- i. Robust
- ii. Equitable and inclusive
- iii. Responsive
- iv. Focused on effective implementation

Insights as to what South Africa is currently doing to address these in the context of the developing national strategy on biological invasion are discussed in Wilson et al. (2025). A few are highlighted here.

There are significant gaps in information flow that would be addressed by effective integrated governance this is in part due to overlaps in legislation. For example, protected areas are required to produce a management plan under the National Environmental Management: Protected Areas Act 57 of 2003. There is no specific requirement that such a plan addresses biological invasions, though to be effective it would almost certainly have to and Section 76 of the NEM:BA instructs that invasive species control and eradication must be incorporated into protected area management plans. Whether having a separate site-based control plan for invasions is necessary is moot, but if a plan is developed such information should flow through to DFFE for evaluation of the '4.9 *effectiveness of site treatments*'

[Note: to be added a discussion on the role of working groups, volunteer hack groups, international agreements]

5.7. Summary of progress to meet GBF Target 6

The Kunming-Montreal Global Biodiversity Framework (GBF) was adopted by the CBD in December 2022 with four 4 goals for 2050 and 23 targets for 2030, including target 6 on biological invasions

Target 6: Reduce the Introduction of Invasive Alien Species by 50% and Minimize Their Impact

Eliminate, minimize, reduce and or mitigate the impacts of invasive alien species on biodiversity and ecosystem services by identifying and managing pathways of the introduction of alien species, preventing the introduction and establishment of priority invasive alien species, reducing the rates of introduction and establishment of other known or potential invasive alien species by at least 50 per cent, by 2030, eradicating or controlling invasive alien species especially in priority sites, such as islands. [25]

In October 2024 as part of the 7th national reports to the CBD[26], South Africa reported that the national target title was:

By 2030, prevent and reduce the rate of introduction and spread of alien invasive species [sic]*, manage the pathways and reduce the threat of alien invasive species* [sic]*.*

and that the main policy measures or actions that will be taken to achieve this national target were:

(1) Pathways responsible for the introduction and spread of (new and/or unregulated) invasive alien species are identified, prioritized, and managed to prevent/reduce the rate of introductions

(2) Major negative impacts of priority invasive alien species have been prevented, eliminated, minimized, reduced and/or mitigated

(3) Major negative impacts of invasive alien species on priority sites - including, sensitive, protected/pristine areas; are minimized/prevented/reduced to restore, maintain and enhance natures [sic] *contributions to the people*

(4) Implementation of a range of interventions is accelerated through integrated governance at all levels for the management and control of invasive alien species

Additional financial resources were indicated as necessary or the attainment of this national target (cf. Section 4.2).

Section S5.1 provides details of how information in this status report can contribute to a summary of progress to meet GBF Target 6.

[25] https://www.cbd.int/gbf/targets/6
[26] https://ort.cbd.int/national-targets/my-country/part-1/AA683CEB-86AA-143D-EC80-4098C4AAB7B1/view (accessed 27 Jan 2026)

6. Gaps

Lead authors: Tsungai A. Zengeya, Katelyn T. Faulkner, Masingitla P. Mtileni, Brian W. van Wilgen, John R. Wilson

Contributing authors: Tumeka Mbobo

Process for identifying gaps and key findings

This chapter evaluates gaps using four approaches: 1) progress in collating information needed for the indicators used in this report was evaluated and gaps in this process noted (Section 6.1 and Table 6.1); 2) the needs of stakeholders and end users of the report were evaluated through a questionnaire run in parallel with the external review of this report, with findings evaluated in terms of what is feasible for the report given different levels of resourcing (Section 6.2); 3) gaps identified in the third report (SANBI and CIB, 2023) (including gaps in information, management, and governance) were re-evaluated (Sections 6.3–6.7); and 4) gaps identified in the IPBES IAS Assessment were evaluated in the South African context (Section 6.8). The chapter concludes with Section 6.9: the way forward. Key findings are highlighted below:

- Processes to identify information are increasingly available but incomplete, with workflows and protocols to ensure such information is collated and, as appropriate, reported on. This systematic collation and presentation of data via workflows will facilitate more regular and accurate updates on the status and management of biological invasions.
- Indicators are crucial for interpreting information in a policy- and management-relevant manner. The indicators developed for this report have been evaluated against fundamental properties of indicators as part of updating indicators factsheets, and efforts are on-going to align indicators with national and international reporting processes. Much more is needed to test and refine the indicators, in particular, by expanding evaluations to explore how indicators are perceived and communicated so that they incentivise the appropriate behaviour.
- There are major gaps in our knowledge on introduction rates, with pathways and dates of introduction missing for many introduced taxa, particularly plants and fungi. Estimates or useful proxies of search effort are required for more reliable estimates of rate of introduction and to report on Target 6 of the GBF.
- Data on how invasive species move and are moved around South Africa (and potential methods to collect and curate such data) are needed if effective strategies to manage the spread of invasions are to be developed.

- Data on the presence, distribution and abundance of alien species need to be systematically collected, collated, and integrated into national and global databases to facilitate the planning of interventions.
- Information on the impacts of biological invasions needs to be systematically quantified and collated to facilitate the prioritisation of interventions, provide a defensible rationale to underpin government investment, and provide background to efforts to communicate the severity of the issue.
- Interventions on biological invasions in South Africa are occurring in the absence of a comprehensive policy, and a strategy to guide and implement such a policy (noting existing and new policies only address part of the issue of biological invasions). A national strategy is under development that has the potential to significant increase the integrated governance, though other co-ordination structure might also be effective (e.g., on One Biosecurity).
- Formal programs that monitor progress towards reducing the negative impacts of invasions (outputs and outcomes) are not available, but if established would allow for control measures to be compared and improved.
- [Note: the following is a key finding from the previous report, it will be revised based on results of stakeholder questionnaire]. There has, to date, been no systematic evaluation of how the report is currently used, what can be done to improve uptake, and how the report can better address stakeholder needs. Broad stakeholder engagement exercises have been used very effectively in similar contexts.

6.1. Progress since the last report in terms of indicators

For each indicator, the evaluation of the progress made towards getting an accurate reflection of the actual situation was evaluated by the report authors based on the information contained in each chapter (Table 6.1).

Table 6.1 Progress on gathering information required to populate the indicators (cf. Figure 0.2) reported on in this report. Progress is scored as: regression—less information is available than previously; none—the information is the same as in previous reports (with appropriate updates as needed); minimal—there has been some more information or processes set up, but these are unlikely to be sufficient to affect the scoring of the indicators; moderate—additional information were obtained allowing for some changes to be detected or necessitating a revised baseline; substantial—the processes have seen a step change in what information is available and/or the information that could be obtained. Results from the previous reports are outlined in full in Table S6.1 as well as an updated evaluation of the consequences if the gap were not filled.

Indicator	**Progress 2017–2019**	**Progress 2020–2022**	**Progress 2023–2025**	**Notes on progress 2023–2025**
1. *Rate of unregulated introduction of new species*	minimal	moderate	moderate	A database on historical introductions of bark and ambrosia beetles was recently published, as were data from social media on bird escapes. A workflow to check sources for new introductions and to process these data has been developed (Appendix 2: '*Workflow to check sources for new introductions*'). With new indicators being developed for reporting at international levels, there is a greater recognition of the need to separate search effort from observations (Section 0.2.2). This promises to be an area where substantial progress can be made.
1.1 *Introduction pathway prominence*	moderate	moderate	minimal	Recent research on some pathways of introduction means that our understanding of certain pathways, such as the aquarium trade, has improved significantly. But many pathways of introduction remain poorly studied. The workflow that supports this indicator (Appendix 2: '*Introduction pathway prominence*') was updated and automated where possible.
1.2. *Introduction rates*	moderate	moderate	moderate	While progress has been made (see indicator 1), there are still significant gaps, e.g., in terms of pathways and dates of introduction.
1.3 *Within-country pathway prominence*	none	minimal	minimal	There have been insights into a few pathways (e.g., due to research on the pet trade, plant uses), but little is still known about most pathways active within South Africa.
1.4 *Within-country dispersal rates*	none	moderate	minimal	A database of native-alien populations, including information on pathways, has been constructed. Information is also available for alien plants in South African National Parks. The pathways for other taxa dispersing within the country, however, remain unknown or the available information needs to be collated.
2. *Number of invasive species that have 'Major' impacts*	minimal	moderate	minimal	Impact assessments have been conducted for only a few alien taxa in South Africa. Complementary assessments using risk analyses and findings from the IPBES IAS Assessment confirm that these species cause widespread harm across multiple sectors of society. The need for more studies and assessments on the impact of invasive species remains a research priority.
2.1. *Number and status of alien species*	substantial	substantial	substantial	The process to compile the list alien species in South Africa has been substantially improved and documented. The focus for the next phase is to increase the number of data-sources incorporated into the list of alien taxa, and to implement protocol and workflow, e.g., for declaring a taxon alien, present, and assessing its degree of establishment (introduced, established, invasive)

Indicator	Progress 2017–2019	Progress 2020–2022	Progress 2023–2025	Notes on progress 2023–2025
2.2. *Extent of alien species*	minimal	minimal	minimal	There is limited data on the extent and abundance of alien species in South Africa. Citizen science continues to provide information on the extent of some species while several atlassing and remote sensing projects have provided estimates of the abundance of selected invasive plant taxa in water catchments and terrestrial biomes. There is however no national long-term structured monitoring project to track plant invasions across South Africa
2.3. *Abundance of alien species*	minimal	none	minimal	
2.4. *Impact of alien species*	minimal	minimal	minimal	There is ongoing development of frameworks and models assessing potential impacts and risks posed. However, as only few taxa have been formally assessed, the need for more studies and assessments on the impact of invasive species has been highlighted as a research priority for South Africa
3. *Extent of area that suffers 'Major' impacts from invasions*	minimal	minimal	none	No progress made
3.1 *Alien species richness*	minimal	none	minimal	Significant increases were seen in various provinces and biomes, although without active surveillance this might be an artefact of more records being submitted to the citizen science platforms iNaturalist
3.2 *Relative invasive abundance*	minimal	none	minimal	At a national level, a 15-year monitoring study has been completed and published, and provides estimates of relative invasive abundance of 14 selected plant taxa in terrestrial biomes and water catchments. There are no reliable estimates for the relative abundance of invasive species at sub-national levels (for example protected areas) due to a lack of structured monitoring programs
3.3 *Impact of invasions*	minimal	moderate	none	Estimates of the impact of invasions have not been recently revised (section S3.3)
4. *Level of success in managing invasions*	minimal	none	none	The absence of robust information on pathways, species and sites treated, and the lack of systems to monitor the outcomes of these interventions, means that there has been little progress in clarifying the overall level of success with managing invasions. The report relies heavily on a small number of studies, usually reported in individual research papers (e.g., Kotzé et al. 2025; van Wilgen et al. 2025)
4.1 *Quality of regulatory framework*	moderate	moderate	minimal	While the implementation of the regulatory framework has been outlined (Figure 5.2); the information needed to evaluate it specified (Table 5.3); and a framework for considering such information developed (Figure 5.1); there have been few improvements in the flow of actual information itself (e.g., on inspections and convictions). By developing the structures, the intention is that future reports will be better placed to collate and evaluate information on the quality of the regulatory framework and how it is being implemented

Indicator	Progress 2017–2019	Progress 2020–2022	Progress 2023–2025	Notes on progress 2023–2025
4.2 *Money spent*	none	moderate	none	There are several issues that continue to limit the ability to track money spent on the management of biological invasions. Few estimates of money spent are received from organisations. The values that are provided often do not separate expenditures based on money received from government (e.g., the WfW programme) from other sources, nor is money spent on managing biological invasions separated from other activities. In many cases (private landowners and volunteer groups in particular) no records are kept, or inputs are in kind rather than financial. Economic methods would be needed to developed for robust and defensible estimates to be produced.
4.3 *Planning coverage*	minimal	minimal	minimal	There are no plans for pathways or species. For sites, the DFFE has recently established a database of plans and made a start with approving them. Few such site plans have been approved to date, noting neither the area covered by such plans nor and whether the plant are current is recorded. Such data are essential for estimating planning coverage
4.4 *Pathways treated*	minimal	minimal	none	Many government departments are involved in the management of pathways though such information is rarely made accessible (cf. Section 6.4). Data inspections for environmental threats continues to be made available despite the change in the entity responsible (was DFFE, now BMA)
4.5 *Species treated*	minimal	minimal	regression	Information on which species have been managed is incorporated into South Africa's list of alien taxa (Zengeya et al. in press) based on information from government or agricultural control or eradication programs, monitoring of biological control agents, and published studies. However, a major source of information (the Working for Water Management Information System, WIMS) is no longer used
4.6 *Sites treated*	none	minimal	regression	Information on the extent of site treatments is recorded for a few protected areas and in a few research studies; organisations seldom respond to requests for inputs on the location and extent of areas managed. A major source of recent information on sites managed (the Working for Water Management Information System, WIMS) is no longer used, and so the level of knowledge of sites treated has decreased
4.7 *Effectiveness of pathway treatments*	minimal	minimal	none	Information on at-border inspections for environmental threats, and the results of those inspections continues to be supplied. Whether these interventions reduce introduction rates is not estimated, and clear information on procedures followed is not available
4.8 *Effectiveness of species treatments*	none	minimal	none	Information on the effectiveness of species treatments is only routinely collected for a few taxa, specifically plants under biological control, some species that are targets for national eradication, and in some research projects
4.9 *Effectiveness of site treatments*	minimal	none	minimal	The results of a long-term project aimed at monitoring trends in priority woody species at a national level was recently published, with insights for the effectiveness of treatments across sites (Kotzé et al. 2025). However, given this project has been terminated and so the values will not be updated, the level of knowledge is expected to decrease and be limited to ad hoc research projects (cf. Table S4.4)

6.2. End user survey

A stakeholder questionnaire was developed with the aim of identifying topics that should be the focus of future reports and to identify how the report is used. The questionnaire was sent out on 30 January 2026 with the first phase of the questionnaire closing 1 March 2026 (i.e., the same time period as the public request to review a draft of this report). See Section S6.2 for further details, and Table S6.2 for the questions).

[Note: the results of the questionnaire and their implications will be discussed in the final report]

6.3. Indicators and workflows

From the last report, the need to link indicators to the Global Biodiversity Framework (GBF) was highlighted, work on this is on-going recognising data limitations (cf. Sections 0.2.2, 1.5, Box 1.1). The indicator factsheets were updated (Appendix 1), and each indicator evaluated against essential properties for such indicators (Vicente et al. 2022).

A continuing gap is the disconnect between information that is apparently available and that which is used in this report to evaluate the status and management of biological invasions in South Africa (e.g., Table 6.1). There are various potential reasons for this: the information has not, in fact, been collected; the information is not stored in a manner that allows for sharing; organisations are unaware of their obligations to share data; organisations do not realise particular data are relevant; and there might be a reticence to share data.

To address these issues several strategies have been used or are proposed:

- Which data should be collected for required decisions to be made are now, at least in part, explicitly outlined as part of idealised flow diagrams for some interventions (Figure 5.2);
- To encourage inputs, various stakeholder engagements have been held (Section 0.1.5), and a stakeholder survey has been sent out as part of this report (Section 6.2);
- Data translation tables and tidy versions of data sets have been created to ensure data can be used [e.g., the list of alien taxa (Appendix 6), the metadata associated with the list of alien taxa (Appendix 8), and the permit database (Appendix 9)];
- Various workflows have been established with specific protocols for obtaining information, e.g., '*Tracking data sources and adding data as published*' (Appendix 2); and
- [Planned] standardised templates for data submission per indicator, per data sources (e.g., for particular institutions or individuals), or for particular groups (e.g., marine taxa) are to be prioritised as part of the next report cycle.

It will also be important to evaluate the degree to which the indicators can be effectively communicated and promote desired behaviour.

6.4. Pathways

There are major gaps in our knowledge on *introduction rates*, with pathways being 'unknown' for 49% of introduced taxa, and dates of introduction or first record missing for 65% of introduced taxa. These data gaps are particularly prevalent for plants and fungi, but there are also substantial gaps for invertebrates (Figure S6.1). Such data gaps greatly impact our understanding of how and when alien species were introduced, our ability to direct interventions to where they are required, and our estimates of how effective those interventions are (cf. Chapter 5). Date of introduction data are likely not available for most taxa, however, for many taxa date of first record data should be available, and while for introduction pathways direct evidence seldom exists, pathways in most cases can be inferred (Essl et al. 2015). These gaps need to be addressed through directed research [e.g., introduction history studies such as those of Shepard et al. (2025)] and through efforts to improve the flow of information on records of new alien species into local and global datasets. In addition, introduction rates will need to be modelled based on dates of first record [as is currently recommended, see Buba et al. (2024)]. This will require survey effort data, which is currently lacking, or the identification of useful proxies. Additional capacity to do this is required as is a priority for future reports.

There has been progress on a framework to categorise pathways within a country (Box 1.1), however, information on how species are dispersing within South Africa have not been collated. Without this information interventions to reduce such dispersal cannot be directed, invasive species will continue to spread rapidly, and impacts will increase.

6.5. Species

The process for collating a list of alien taxa for South Africa has been substantially improved and documented (Zengeya et al. 2025, in press). The development of repeatable workflows, following international best practices, ensures it is clear why a taxon is on the list and facilitates updates. Biological invasions are dynamic in nature, and therefore there is a need to regularly update the list of alien taxa. Therefore, the focus of future work is to increase the number of data-sources incorporated into the list, and to formalise processes for declaring a taxon alien, present (e.g., Matthys et al. 2025), and for assessing its degree of establishment (introduced, established, invasive). Processes have also been developed to incorporate new information as it becomes available (e.g., Faulkner in press, Fernández Winzer et al. 2025a).

Several challenges remain, such as significant gaps in knowledge of the presence and distribution of taxa not currently covered by specific atlassing projects. For example, the numbers of alien terrestrial plant species and vertebrate species are well documented, but there is less information for other groups such as invertebrates, soil organisms, and microorganisms (Janion-Scheepers et al. 2016, Janion-Scheepers and Griffiths 2020, Wood et al. 2017). There is ongoing development of frameworks and models assessing potential impacts and risks posed (e.g., Bacher et al. 2025, Boulesnane-Guengant et al. 2025). However, as only few taxa have been formally assessed, the need for more studies and assessments on the impact of invasive species remains a research priority for South Africa.

6.6. Sites

Citizen science continues to provide information on the extent of some species, with notable increase in observations around urban areas (e.g., Gildenhuys et al. 2025). However, there are no national long-term structured monitoring projects to track invasions across South Africa. As a result, the only reliable estimates on the extent and abundance of invasions across the country are from a few atlassing and remote sensing projects on selected invasive plant taxa in water catchments and terrestrial biomes (see Boxes 3.1 and 3.2). Previous reports noted that biological invasions continue to cause 'Major' impacts on biodiversity, ecosystem services, and human livelihoods. However, recent efforts to revise and update these estimates were unsuccessful (see Section S3.3). National and local scale estimates and maps of the impact of invasions are needed to appropriately prioritise interventions across sites and so that interventions can be adjusted to respond to invasions before such invasions are widespread and damaging.

6.7. Interventions

Interventions aimed at preventing the introduction of invasive species or reducing their impacts need to be carefully planned and monitored, within a framework of adaptive management, if they are to be effective. The absence of management plans for regulating the pathways of introduction and spread, and for dealing with priority species represents a significant gap. While some site management plans exist, the coverage of the plans is low, and many site plans do not have clear and realistic goals. Monitoring programs aimed at tracking progress towards goals, and taking corrective actions when progress is not satisfactory, are typically absent. The capacity and resources that would be needed to fund the development of such plans, to adequately and sustainably fund their implementation, and to monitor progress towards achieving their goals were not explicitly addressed in this report, but these gaps will continue to make the assessment of effectiveness of interventions difficult.

South Africa's regulatory framework is based on the premise of regulating all harmful or potentially harmful alien taxa. However, this is not the only option. Rather than specifying what cannot be used it can be more effective to specify options that can be used. Kumschick et al. (2025) expanded on the concept of a 'safe list' that they defined as 'a list of taxa alien to the region of interest that are considered of sufficiently low risk of invasion and impact that the taxa can be widely used without concerns of negative impacts.'. They developed a generalised protocol for developing such lists. Potgeiter et al. (2025) applied these concepts to develop a workflow for identifying tree taxa that can be used without concerns of exacerbating invasions (either of the trees themselves or of pest and pathogens). In context of the outbreak of the *Euwallacea fornicatus* (polyphagous shot hole borer) they created such a list for Cape Town. On a similar note, Chetty et al. (2024) reviewed how 'sterile' cultivars of listed alien plants were addressed under the A&IS Regulations, and developed recommendations for how 'safe' cultivars could be identified and exempt from regulation. Regulation is, of course, legally binding, but comes at the costs of flexibility. Kumschick et al. (2025) also discussed voluntary options, including certification, codes of conduct, and informal lists to raise awareness. The WfW programme had a campaign of 'Plant me instead' to identify native alternative to listed alien ornamental plants. The value of such approaches in building relationships and the extent to which non-regulatory options are available and used could be an important addition to future reports, with the role of voluntary agreements potentially to be added to the evaluation of the regulatory framework.

6.8. Gaps identified in the IPBES IAS Assessment

Wilson et al. (2025) evaluated gaps identified in the IPBES IAS Assessment (IPBES 2023) in the context of the South African situation with suggestions for actions that can be adopted as part of the national strategy on biological invasions. An adapted version of the analysis is included in the supplementary material presented here (Table S6.2). The overall conclusion from the comparison was that:

Some gaps at a global level…were not as applicable to South Africa (South Africa has relatively good inventories when compared with many countries around the world). Many of the identified actions to fill gaps (e.g., the need for systems to track the effectiveness of interventions) have already been identified as part of the South African status reports … and are under consideration in the draft national strategy. There also appears to be a need to integrate global and national needs. Nonetheless, the process helped us develop some specific actions that should be considered (e.g., the need to support general surveys of alien invertebrates and microorganisms; the need to promote transdisciplinary work and draw more on integrative social-ecological systems thinking; and actions to improve participation of communities in decision-making). Finally, there are a range of valuable South African specific *databases and knowledge products (e.g., on research, policy, compliance and enforcement, and management best practice). Consolidating such information so it is findable, accessible, inter-operable, and reusable (i.e., FAIR; Wilkinson et al. 2016) and better co-ordination between the various organisations that collect and curate data will be essential if governance is to be integrated.*

6.9. The way forward

Given the mandate of this report arises from the NEM:BA (See Section 0.1.2) and the funding for it comes from the DFFE, the report is naturally focussed on environmental issues. However, it is increasingly recognised that addressing biological invasions would require integrated governance as the issues are cross-sectoral (IPBES, 2023). For example, an evaluation of biological invasions is essential for the One Health approach to be successful (e.g., thought consideration of One Biosecurity, Hulme et al. 2025; Box 1.2).

Several future goals for the report have been proposed, noting that in each case the ability to address the goal will depend on resources [Note, this will be adapted based on stakeholder consultation].

- Support strategic review of progress on the NISSAP;
- Legal review of the legislation framework around biological invasions;
- Link to the status of biological invasions in neighbouring countries;
- Improved presentation of impacts and management in economic terms;
- Impacts assessed for priority taxa;
- Track progress made across goals from previous reports to changes over time (including developing workflows for all the indicators); and
- Processes in place to work on impacts on sites

Revisions to the A&IS Regulations that are underway as well as the development of the national strategy on biological invasions offer opportunities to refine the scope and expectations of this report (e.g., the proposal to move to decadal reports with annual updates provided as part of a dashboard of indicators; Table 0.1, Section 0.4). Additional mechanisms might be needed, however, if this report is to have the legitimacy and acceptability as a mechanism to promote integrated governance.

Acknowledgements

The drafting team would like to thank the members of the Reference and Advisory Committee for their guidance and advice on the process of compiling the third Status Report, and for reviewing all the drafts of the report (see page ii for a list of those involved). In addition, the following are thanked for their insightful comments on drafts of the status report and the summary of key messages: … [Note: to be added].

Funding for this report was primarily provided by the South African Department of Forestry, Fisheries, and the Environment (DFFE), noting that this report does not necessarily represent the views or opinions of DFFE or its employees. Support was also received from the B-Cubed project (Biodiversity Building Blocks for Policy), which is funded by the European Union's Horizon Europe Research and Innovation Programme (ID No. 101059592). Views and opinions expressed are, however, those of the authors only and do not necessarily reflect those of the European Union or the European Commission. Neither the EU nor the EC can be held responsible for them. The Centre for Invasion Biology, School for Climate Studies, Stellenbosch University also provided support.

References

Ackland SJ, Andersen MN, Kock A, van Blerk D, Ariefdien R, Robinson TB (2025) First record of the marine alien bryozoan *Amathia verticillata* (delle Chiaje, 1822) in South Africa. BioInvasions Records 14: 183–196. https://doi.org/10.3391/bir.2025.14.1.15

Adams LD (2024) Assessment of fleshy-fruited invasive alien plants in eastern South African grasslands using community perceptions, seed germination and dispersal, and repeat photography. PHD Thesis. University of KwaZulu-Natal (Pietermaritzburg).

Bacher S, Ryan-Colton E, Coiro M, Cassey P, Galil B, Nunez M, Ansong M, Dehnen-Schmutz K, Fayvush G, Fernandez R, Hiremath A, Ikegami M, Martinou A, McDermott S, Preda C, Vila M, Weyl O, Pepori A, Martinez HR, Demetriou J, Pertierra LR, de Groot M, Khan MA, Early R, Sohrabi S, Atkore V, Pienaar E, Liu C, Pyšek P, Shivambu T, Carbutt C, Aravind N, Joelson N, Lapin K, Brockerhoff E, Jeschke J, Measey J, van 'T Hof P, Torres GR, Nahrung H, Cisneros-Heredia D, Trillo A, Hui C, Zengeya T, Barney J, Santini A, Gallardo B, Evans T, Scalera R, Sánchez R, Schmidt L, Kumschick S, Santoro D, Musseau C, Dickey J, Rojas-Sandoval J, Gruber M, Ryan-Schofield N, Carisio L, Blackburn T, Lioy S, Mazzitelli M, Volery L, Mrugała-Koese A, Lach L, Tricarico E, MacMullen Z, Athanasiou K, Cooling M, Céspedes V, Christopoulou A, Duboscq V, Angelidou I, Castro-Diez P, and Flores-Males P (2025) Global Impacts Dataset of Invasive Alien Species (GIDIAS). Scientific Data 12:832. https://doi.org/10.1038/s41597-025-05184-5

Balocchi F, Wingfield MJ, Paap T (2024) First report of Fusarium Wilt and Pink Rot of *Phoenix canariensis* in South Africa. Forest Pathology 54(6): e70001. https://doi.org/10.1111/efp.70001

Balocchi F, Wingfield MJ, Paap T (2025) First record of the white root rot fungus *Dematophora necatrix* on indigenous South African trees. Journal of Plant Pathology 107: 1229–1233. https://doi.org/10.1007/s42161-025-01861-x

Bates MF, Branch WR, Bauer AM, Burger M, Marais J, Alexander GJ, de Villiers MS (2014) Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. South African National Biodiversity Institute, Pretoria.

Biodiversity Indicator Partnership (2011) Guidance for National Biodiversity Indicator Development and Use. UNEP World Conservation Monitoring Centre. Cambridge, UK. https://www.cbd.int/doc/meetings/ind/ahteg-sp-ind-01/other/ahteg-sp-ind-01-bipnational-en.pdf

Blackburn TM, Pyšek P, Bacher S, Carlton JT, Duncan RP, Jarošík V, Wilson JRU, Richardson DM (2011) A proposed unified framework for biological invasions. Trends in Ecology & Evolution 26: 333–339. https://doi.org/10.1016/j.tree.2011.03.023

Boulesnane-Guengant O, Rouget M, Becker-Scarpitta A, Botella C, Kumschick S (2025) Spatialising the ecological impacts of alien species into risk maps. Global Ecology and Conservation 61: e03660. https://doi.org/10.1016/j.gecco.2025.e03660

Brooks M, Rose S, Altwegg R, Lee AT, Nel H, Ottosson U, Retief E, Reynolds C, Ryan PG, Shema S, Tende T, Underhill LG, Thomson RL (2022) The African Bird Atlas Project: A description of the project and BirdMap data-collection protocol. Ostrich 93(4): 223–232. https://doi.org/10.2989/00306525.2022.2125097

Brooks M, Ryan P (2023) Southern African Bird Atlas Project 2 [dataset]. FitzPatrick Institute of African Ornithology. https://www.gbif.org/dataset/906e6978-e292-4a8b-9c39-adf6bb0f3323

Buba Y, Kiflawi M, McGeoch MA, Belmaker J (2024) Evaluating models for estimating introduction rates of alien species from discovery records. Global Ecology and Biogeography 33(8): e13859. https://doi.org/10.1111/geb.13859

CBD (2014) Pathways of introduction of invasive species, their prioritization and management. Technical Report UNEP/CBD/SBSTTA/18/9/Add.1: 1–18. https://www.cbd.int/ doc/meetings/sbstta/sbstta-18/official/sbstta-18-09-add1-en.pdf

CBD and ICUN (2024) Invasive Alien Species Toolkit for Target 6 of the Kunming-Montreal Global Biodiversity Framework. The Secretariat of the Convention on Biological Diversity. pp.55. https://www.cbd.int/invasive/cbdtoolkit

Chan DTC, Poon ESK, Wong ATC, Sin SYW (2021) Global trade in parrots – influential factors of trade and implications for conservation. Global Ecology and Conservation 30: 0–3. https://doi.org/10.1016/j.gecco.2021.e01784

Chao A, Kubota Y, Zelený D, Chiu C-H, Li C-F, Kusumoto B, Yasuhara M, Thorn S, Wei C-L, Costello MJ, Colwell RK (2020) Quantifying sample completeness and comparing diversities among assemblages. Ecological Research 35:292–314. https://doi.org/10.1111/1440-1703.12102

Cheney C, Esler KJ, Foxcroft LC, van Wilgen NJ (2020) The dominating influence of efficacy above management strategy in the long-term success of alien plant clearing programmes. Journal of Environmental Management 271: 110836. https://doi.org/10.1016/j.jenvman.2020.110836

Cheney C, Esler KJ, Foxcroft LC, van Wilgen NJ, McGeoch MA (2018) The impact of data precision on the effectiveness of alien plant control programmes: a case study from a protected area. Biological Invasions 20: 3227–3243. https://doi.org/10.1007/s10530-018-1770-8

Chetty D, Datta A, Kumschick S, Wilson JRU, Nchu F, Geerts S (2024) Regulatory options for cultivars and hybrids of invasive plant species—the South African experience. Invasive Plant Science and Management 17: 228–238. https://doi.org/10.1017/inp.2024.24

Coetzee JA, Langa SDF, Motitsoe SN, Hill MP (2020) Biological control of water lettuce, *Pistia stratiotes* L., facilitates macroinvertebrate biodiversity recovery: a mesocosm study. Hydrobiologia 847:3917–3929

Coetzee JA, Miller BE, Kinsler D, Sebola K, Hill MP (2022) It’s a numbers game: Inundative biological control of water hyacinth (*Pontederia crassipes*) yields success at a high elevation, hypertrophic impoundment in South Africa. Biocontrol Science and Technology 32:1302–1311. https://doi.org/10.1080/09583157.2022.2109594

Cogill LS, Toucher M, Wolski P, Esler KJ, Rebelo AJ (2025) Evaluating the performance of satellite-derived evapotranspiration products across varying bioclimates in South Africa. Remote Sensing Applications: Society and Environment, 29, 101612. https://doi.org/10.1016/j.rsase.2025.101612

Collop A, Terblanche JS, Clusella-Trullas S, Garnas JR, Bradicich P, Karsten M (2024) Testing hypotheses of invasion pathways of the ladybird *Harmonia axyridis* into and across South Africa. Biological Invasions. https://doi.org/10.1007/s10530-024-03274-w

Crookes S, Heer T, Castañeda RA, Mandrak NE, Heath DD, Weyl OLF, MacIsaac HJ, Foxcroft LC (2020) Monitoring the silver carp invasion in Africa: a case study using environmental DNA (eDNA) in dangerous watersheds. NeoBiota 56: 31-47. https://doi.org/10.3897/neobiota.56.47475

D’Amato ME, Esterhuyse MM, van Der Waal BCW, Brink D, Volckaert FAM (2007) Hybridization and phylogeography of the Mozambique tilapia *Oreochromis mossambicus* in southern Africa evidenced by mitochondrial and microsatellite DNA genotyping. Conservation Genetics 8: 475–488.

Dallas H, Shelton J, Sutton T, Tri Cuptura D, Kajee M, Job N (2022) The Freshwater Biodiversity Information System (FBIS)–mobilising data for evaluating long-term change in South African rivers. African Journal of Aquatic Science 47: 291–306. https://doi.org/10.2989/16085914.2021.1982672

Dalu T, Stam EM, Ligege MO, Cuthbert RN (2023) Highways to invasion: powerline servitudes as corridors for alien plant invasions. Journal of African Ecology 61: 379–388. https://doi.org/10.1111/aje.13121

Davies SJ, Bell JA, Impson D, Mabin C, Meyer M, Rhoda C, Stafford L, Stephens K, Tafeni M, Turner AA, van Wilgen NJ, Wilson JRU, Wood J, Measey J (2020) Coordinating invasive alien species management in a biodiversity hotspot: The CAPE Invasive Alien Animals Working Group. Bothalia, African Biodiversity & Conservation 50: a10. https://doi.org/10.38201/btha.abc.v50.i1.10

Department of Home Affairs (2023) Withdrawal of Zanzinbar as a designated port of entry. Government Notice No 4111. https://www.gov.za/sites/default/files/gcis_document/202311/49766gon4111_1.pdf

Dijkstra K-DB (2016) African Dragonflies and Damselflies Online. (Version 1 July 2016). Available online at http://addo.adu.org.za

Dippenaar-Schoeman AS, Haddad CR, Foord SH, Lyle R, Lotz LN, Marais P (2015) South African National Survey of Arachnida (SANSA): Review of current knowledge, constraints and future needs for documenting spider diversity (Arachnida: Araneae). Transactions of the Royal Society of South Africa 70(3): 245–275. https://doi.org/10.1080/0035919X.2015.1088486

Emre Can Ö, D’Cruze N, Macdonald DW (2019) Dealing in deadly pathogens: Taking stock of the legal trade in live wildlife and potential risks to human health. Global Ecology and Conservation 17: e00515. https://doi.org/10.1016/j.gecco.2018.e00515

Essl F, Bacher S, Blackburn TM, Booy O, Brundu G, Brunel S, Cardoso A-C, Eschen R, Gallardo B, Galil B, García-Berthou E, Genovesi P, Groom Q, Harrower C, Hulme PE, Katsanevakis S, Kenis M, Kühn I, Kumschick S, Martinou AF, Nentwig W, O’Flynn CO, Pagad S, Pergl J, Pyšek P, Rabitsch W, Richardson DM, Roques A, Roy HE, Scalera R, Schindler S, Seebens H, Vanderhoeven S, Vilà M, Wilson JRU, Zenetos A, Jeschke

JM (2015) Crossing frontiers in tackling pathways of biological invasions. BioScience 65: 769–782. https://doi.org/10.1093/biosci/biv082

Faulkner KT (in press) An automated workflow to standardise taxon names for South African alien species lists. African Biodiversity & Conservation.

Faulkner KT, Hulme PE, Pagad S, Wilson JRU, Robertson MP (2020) Classifying the introduction pathways of alien species: are we moving in the right direction? NeoBiota 62: 143–159. https://doi.org/10.3897/neobiota.62.53543

Faulkner KT, Hulme PE, Wilson JRU (2024) Harder, better, faster, stronger? Dispersal in the Anthropocene. Trends in Ecology and Evolution 39: 1130–1140. https://doi.org/10.1016/j.tree.2024.08.010

Faulkner KT, Spear D, Robertson MP, Rouget M, Wilson JRU (2015) An assessment of the information content of South African alien species databases. Bothalia: African Biodiversity and Conservation 45: 11 pages (Art. #1103). https://doi.org/10.4102/abc.v45i1.1103

Fenner F, Henderson DA, Arita I, Ježek Z, Ladnyi ID (1988) Chapter 31: Lessons and benefits. Smallpox and its eradication. World Health Organisation, Geneva, 1345–1370.

Fernández Winzer L, Faulkner KT, Paap T, Wilson JRU (2025a) From detection to action—a proposed workflow to ensure first reports of alien species from molecular analyses are acted upon. NeoBiota 104: 339–359. https://doi.org/10.3897/neobiota.104.162310

Fernández Winzer L, Greve M, le Roux PC, Faulkner KT, Wilson JRU (2025b) Using indicators to assess the status of biological invasions and their management on islands–the Prince Edward Islands, South Africa as an example. Biological Invasions 27: article 108 (13 pages). https://doi.org/10.1007/s10530-024-03463-7

Firmat C, Alibert P, Losseau M, Baroiller JF, Schliewen UK (2013) Successive invasion-mediated interspecific hybridizations and population structure in the endangered cichlid *Oreochromis mossambicus*. Plos One 8: 1–12. https://doi.org/10.1371/journal.pone.0063880

Foxcroft L, van Wilgen NJ, Baard J, Cole N (2017) Biological invasions in South African National Parks. Bothalia 47: a2158. https://doi.org/10.4102/abc.v47i2.2158

Freitag-Ronaldson S (ed) (2005) Kruger National Park (KNP). 2005. Revision of the management plan for the Kruger National Park, Part 1: Objectives hierarchy. South African National Parks.

Gildenhuys CP, Potgieter LJ, Hui C, Richardson DM (2025) Deriving inventories of non-native plant species from iNaturalist: Insights from urban centres of the Western Cape, South Africa. Neobiota 104: 27–58. https://doi.org/10.3897/neobiota.104.155832

Glen HF (2002) Cultivated plants of southern Africa: botanical names, common names, origins, literature. Jacana, Johannesburg.

Goldman GB, Gryzenhout M (2019) Field guide to mushrooms & other fungi of South Africa. Struik Nature, Cape Town, 360 pp. ISBN: 9781775846543.

Groom Q, Abraham L, Adriaens T, Breugelmans L, Clarke D, Di Musciano M, Dove S, Estupinan-Suarez L, Faulkner KT, Fernandez M, Hendrickx L, Hui C, Joly A, Kumschick S, Langeraert W, Martini M, Miller J, Oldoni D, Pereira H, Preda C, Robertson T, Rocchini D, Rodrigues A, Ryckewaert M, Seebens H, Sica Y, Teixeira H, Trekels M, Vandaele T, Wilson J, Zengeya T, Desmet P (2025) Creating the vision of rapid, repeatable, reactive data workflows for policy on biodiversity. Ecological Solutions and Evidence 6: e70113. https://doi.org/10.1002/2688-8319.70113

Harris DB (2009) Review of negative effects of introduced rodents on small mammals on islands. Biological Invasions 11: 1611–1630. https://doi.org/10.1007/s10530-008-9393-0.

Harrower CA, Scalera R, Pagad S, Schönrogge K, Roy HE (2018) Guidance for interpretation of CBD categories on introduction pathways. Technical note prepared by IUCN for the European Commission.

Hart LA, Downs CT (2014) Public surveys of rose-ringed parakeets, *Psittacula krameri*, in the Durban Metropolitan area, South Africa. African Zoology 49(2): 283–289, https://doi.org//10.1080/15627020.2014.11407644.

Henderson L (2007) Invasive, naturalized and casual alien plants in southern Africa: A summary based on the Southern African Plant Invaders Atlas (SAPIA). Bothalia 37(2): 215–248. https://doi.org/10.4102/abc.v37i2.322

Hoffmann JH, Moran VC, Zimmermann HG, Impson FAC (2020) Biocontrol of a prickly pear cactus in South Africa: reinterpreting the analogous, renowned case in Australia. Journal of Applied Ecology 57:2475–2484. https://doi.org/10.1111/1365-2664.13737

Holden PB, Rebelo AJ, New MG (2021) Mapping invasive alien trees in water towers: A combined approach using satellite data fusion, drone technology and expert engagement. Remote Sensing Applications: Society and Environment 21:100448. https://doi.org/10.1016/j.rsase.2020.100448

Hoy LH, Brown LR, Hendrick RM, Barrett AS (2021) Determining a landscape plant database matched to hydrozones for South Africa. Journal of Applied Horticulture, Society for Advancement of Horticulture 23(1): 28–36. http://dx.doi.org/10.37855/jah.2021.v23i01.06

Hulme PE (2020) One Biosecurity: a unified concept to integrate human, animal, plant, and environmental health. Emerging Topics in Life Sciences 4: 539–549. https://doi.org/10.1042/ETLS20200067

Hulme PE, Dechoum MS, Essl F, Martinou AF, Pauchard A, Pyšek P, Roy HE, Sheppard AW, Vilà M, Wilson JRU (2025) One Biosecurity is essential to implement One Health. Bioscience: biaf110. https://doi.org/10.1093/biosci/biaf110

Hulme PE, Ikeda T, Vandvik V, Blanchard R, Camacho-Cervantes M, Herrera I, Koyama A, Morales CL, Munishi LK, Pallewatta PKTNS, Per E, Pergl J, Ricciardi A, Xavier RO (2023) Chapter 3: Drivers of biodiversity change affecting biological invasions. In Thematic Assessment Report on Invasive Alien Species and their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (eds HE Roy, A Pauchard, P Stoett, T Renard Truong), pp. 261–390. IPBES secretariat, Bonn. https://doi.org/10.5281/zenodo.7430727

IPBES (2018) IPBES Guide on the production of assessments. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany, 44 pp. https://doi.org/10.5281/zenodo.7568074

IPBES (2023) Summary for Policymakers of the Thematic Assessment Report on Invasive Alien Species and their Control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://doi.org/10.5281/zenodo.7430692

IPBES (2023) Thematic assessment report on invasive alien species and their control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. In: Roy HE, Pauchard A, Stoett P, Renard Truong T (Eds). IPBES secretariat, Bonn, Germany, 890 pp. https://doi.org/10.5281/zenodo.7430682

Ivey PJ, Hill MP, Zachariades C (2021) Advances in the regulation of weed biological control in South Africa. African Entomology 29: 1060–1076, 1017. https://doi.org/10.4001/003.029.1060

Janion-Scheepers C, Griffiths CL (2020) Alien terrestrial invertebrates in South Africa. In: van Wilgen BW, Measey J, Richardson DM, Wilson JR, Zengeya TA (eds) Biological invasions in South Africa. Springer, Berlin, pp 183–204. https://doi.org/10.1007/978-3-030-32394-3_7

Janion-Scheepers C, Measey J, Braschler B, et al. (2016) Soil biota in a megadiverse country: Current knowledge and future research directions in South Africa. Pedobiologia 59: 129–175. https://doi.org/10.1016/j.pedobi.2016.03.004

Jetz W, McGeoch MA, Guralnick R, Ferrier S, Beck J, Costello MJ, Fernandez M, Geller GN, Keil P, Merow C, Meyer C, Muller-Karger FE, Pereira HM, Regan EC, Schmeller DS, Turak E (2019) Essential biodiversity variables for mapping and monitoring species populations. Nature Ecology & Evolution 3: 539–551. https://doi.org/10.1038/s41559-019-0826-1

Kalwij JM, Robertson MP, van Rensburg BJ (2015) Annual monitoring reveals rapid upward movement of exotic plants in a montane ecosystem. Biological Invasions 17(12): 3517–3529. https://doi.org/10.1007/s10530-015-0975-3

Kaplan H, Wilson JRU, Klein H, Henderson L, Zimmermann HG, Manyama P, Ivey P, Richardson DM, Novoa A (2017) A proposed national strategic framework for the management of Cactaceae in South Africa. Bothalia: African Biodiversity and Conservation 47: a2149. https://doi.org/10.4102/abc.v47i2.2149

Katsanevakis S, Olenin S, Puntila-Dodd R, et al. (2023) Marine invasive alien species in Europe: 9 years after the IAS Regulation. Frontiers of Marine Science 10: 1271755. https://doi.org/10.3389/fmars.2023.1271755

Kerr GN, Sharp BMH (2008) Biodiversity management: Lake Rotoiti choice modelling study. Research Report 310, Agribusiness & Economics Research Unit, Lincoln University, 37

Klein H, Zimmermann HG, Xivuri T (2020) Exceptional biological control of two varieties of *Cylindropuntia fulgida* (Cactaceae) in South Africa using a recently-identified different biotype of the cochineal insect, *Dactylopius tomentosus* (Dactylopiidae). Biological Control 149:104314. https://doi.org/10.1016/j.biocontrol.2020.104314

Kotzé JDF, Beukes HB, Newby TS, van den Berg EC (2010) National invasive alien plant survey. Agricultural

Research Council - Institute for Soil, Climate and Water, Pretoria.
Kotzé JDF, Beukes HB, Seifert T (2020) Designing an optimal sampling strategy for a national level invasive alien plant assessment: A South African case study. Ecological Indicators 119:106763. https://doi.org/10.1016/j.ecolind.2020.106763
Kotzé JDF, Wannenburgh A, van Wilgen BW (2025) Changes in the cover of selected invasive alien plant taxa between 2008 and 2023 in South Africa. Biological Invasions 27: 98. https://doi.org/10.1007/s10530-025-03558-9
Kraaij T, Baard JA, Arndt J, Vhengani L, van Wilgen BW (2018) An assessment of climate, weather, and fuel factors influencing a large, destructive wildfire in the Knysna region, South Africa. Fire Ecology 14. https://doi.org/10.1186/s42408-018-0001-0
Kumschick S, Fernandez Winzer L, McCulloch-Jones EJ, Chetty D, Fried J, Govender T, Potgieter LJ, Rapetsoa MC, Richardson DM, van Velden J, Van der Colff D, Miza S, Wilson JRU (2024) Considerations for developing and implementing a safe list for alien taxa. Bioscience 74: 97–108. https://doi.org/10.1093/biosci/biad118
Le Maitre DC, Forsyth GG, Dzikiti S, Gush MB (2016) Estimates of the impacts of invasive alien plants on water flows in South Africa. Water SA, 42(4), 659–672. https://doi.org/10.4314/wsa.v42i4.17
Le Maitre DC, Seyler H, Holland M, Smith-Adao L, Nel JA, Maherry A, Witthüser K (2018) Identification, delineation and importance of the Strategic Water Source Areas of South Africa, Lesotho and Swaziland for surface water and groundwater. Report No. TT 754/1/18 Water Research Commission, Pretoria
Le Maitre, DC, Gaertner M, Marchante E, Ens EJ, Holmes PM, Pauchard, et al. (2011) Impacts of invasive Australian acacias: implications for management and restoration. Diversity and Distributions 17(5): 1015–1029. https://doi.org/10.1111/j.1472-4642.2011.00816.x
Leihy RI, McGeoch MA, Clarke DA, Peake L, Buba Y, Belmaker J, Chown SL (2025) Antarctic Biosecurity Policy Effectively Manages the Rates of Alien Introductions. Earth's Future 13: 1–14. https://doi.org/10.1029/2024EF005405
Liew ECY, Phelan M, McDougall KL (2023) The efficacy of a range of hygiene measures for boot cleaning to protect natural vegetation from *Phytophthora cinnamomi*. Scientific Reports 13: 5825. https://doi.org/10.1038/s41598-023-32681-7
Macdonald IAW, Clark DL, Taylor HC (1989) The history and effects of alien plant control in the Cape of Good Hope Nature Reserve, 1941–1987. South African Journal of Botany 55: 56–75. https://doi.org/10.1016/S0254-6299(16)31233-9
Martin G, Chikowore G, Musedeli J, Stafford L, Watson K, Turner A, Richardson DM, de Lange W, Bogen R, Muir D, Hill M, Slippers B, Hurley B, Ivey P, Harding G, Heath R, Canavan K, du Toit B, van Wilgen BW (2025) Managing wilding pines in the Cape Floristic Region, South Africa: progress and prospects. South African Journal of Botany 177: 377–391. https://doi.org/10.1016/j.sajb.2024.12.011
Martin RO (2018) The wild bird trade and African parrots: past, present and future challenges. Ostrich 89: 139–143. https://doi.org/10.2989/00306525.2017.1397787
Matthys C, Wilson JRU, Geerts S (2026) Argument maps can support decisions to declare the presence of alien species: South Africa as a case study. NeoBiota 105: 113–130. https://doi.org/10.3897/neobiota.105.161591
Mbele TJ, Steenhuisen S-L, Payne SL, Canavan K (2025) Seed germination of cultivated, naturalised and floristically traded *Cortaderia* species in South Africa. South African Journal of Botany 186: 152–162. https://doi.org/10.1016/j.sajb.2025.09.009
McCulloch-Jones EJ, Cuthbert RN, van Wilgen BW, Wilson JRU (2024) Estimating the monetary cost of biological invasions to South Africa. Biological Invasions 26: 3191–3203 https://doi.org/10.1007/s10530-024-03369-4
McGeoch MA, Buba Y, Arlé E, Belmaker J, Clarke DA, Jetz W, Li R, Seebens H, Essl F, Groom Q, García-Berthou E, Lenzner B, Meyer C, Vicente JR, Wilson JRU, Winter M (2023) Invasion trends: An interpretable measure of change is needed to support policy targets. Conservation Letters 16: e12981. https://doi.org/10.1111/conl.12981
Meijninger WML and Jarmain C (2014) Satellite-based annual evaporation estimates of invasive alien plant species and native vegetation in South Africa. Water SA 40, 95–108. http://dx.doi.org/10.4314/wsa.v40i1.12

Milton SJ (1981) Litterfall of the exotic acacias in the south western Cape. Journal of South African Botany 47: 147–155.

Milton SJ, Dean WR (2025) Village aliens: Self-seeding of indigenous and non-indigenous woody garden plants in a small desert village. Journal of Arid Environments 227: 105295. https://doi.org/10.1016/j.jaridenv.2024.105295

Milton SJ, Hoffmann JH, Bowie RCK, D'Amico J, Griffiths M, Joubert D, Loewenthal D, Moinde NN, Seymour C, Toral-Granda MV, Wiseman R (1998) Invasive fountain grass on the Cape Peninsula. South African journal of science, 94(2): 57–58.

Milton SJ, Siegfried WR (1981) Above-ground biomass of Australian acacias in the southern Cape, South Africa. Journal of South African Botany 47(4): 701–716.

Minter LR, Burger M, Harrison JA, Braak HH, Bishop PJ, Kloepfer D (2004) Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. Avian Demography Unit, University of Cape Town.

Miranda NAF, Taylor SJ, Cwewe Y, Appleton CC (2022) First record of the Asian freshwater snail *Sinotaia* cf. *quadrata* (Benson, 1842) from Africa. BioInvasions Records 11: 676–685. https://doi.org/10.3391/bir.2022.11.3.10

Mnqeta Z, Paterson ID (2024) Biological control against *Opuntia aurantiaca* Lindley (Cactaceae) and the perceptions of land-users in the Eastern Cape Province of South Africa. Biocontrol Science and Technology. 34(12): 1165–1177. https://doi.org/10.1080/09583157.2024.2419468

Moffat R, Weaver K, Ngxande-Koza S, Sebola K, English K, Kinsler D, Coetzee J (2024) Bridging boundaries: Six years of community engagement with biological control implementation and monitoring of water hyacinth on Hartbeespoort Dam, South Africa. Biological Control, 105544. https://doi.org/10.1016/j.biocontrol.2024.105544

Moloi KT, Steenhuisen S-L, Adams LD, Downs CT, Martin GD (2024) Only doing half the job: frugivorous birds facilitate the spread but not the germination rate of invasive *Cotoneaster pannosus*. South African Journal of Botany 173: 60–67. https://doi.org/10.1016/j.sajb.2024.08.009

Molokomme PS, Benovics M, Luus-Powell WJ, Lukhele LP, Přikrylová I (2023) *Dactylogyrus* spp. (Dactylogyridae, Monogenea) from tinfoil barb, *Barbonymus schwanenfeldii* imported into South Africa: morphometric and molecular characterisation. Parasite 30: 29. https://doi.org/10.1051/parasite/2023031

Molokomme PS, Rindoria NM, Luus-Powell WJ, Přikrylová I (2025) *Capillaria pterophylli* Heinze, 1933 (Nematoda: Capillariidae Railliet, 1915) in imported ornamental Cichlidae from Asia into South Africa: the first molecular data and scanning electron microscopy. International Journal for Parasitology: Parasites and Wildlife 28: 101153. https://doi.org/10.1016/j.ijppaw.2025.101153.

Moncrieff GR, Slingsby JA, Le Maitre DC (2021) Propagating uncertainty from catchment experiments to estimates of streamflow reduction by invasive alien plants in southwestern South Africa. Hydrological Processes, 35(2), e14161. https://doi.org/10.1002/hyp.14161

Moore JL, Runge MC, Webber BL, Wilson JRU (2011) Contain or eradicate? Optimizing the management goal for Australian acacia invasions in the face of uncertainty. Diversity and Distributions 17: 1047–1059. https://doi.org/10.1111/j.1472-4642.2011.00809.x

Moran VC, Zachariades C, Hoffmann JH (2021) Implementing a system in South Africa for categorizing the outcomes of weed biological control. Biological Control 153:104431. https://doi.org/10.1016/j.biocontrol.2020.104431

Motitsoe SN, Coetzee JA, Hill JM, Hill MP (2020) Biological control of *Salvinia molesta* (D.S. Mitchell) drives aquatic ecosystem recovery. Diversity 12:204. https://doi.org/10.3390/d12050204

Motitsoe SN, Hill JM, Coetzee JA, Hill MP (2022) Invasive alien aquatic plant species management drives aquatic ecosystem community recovery: an exploration using stable isotope analysis. Biological Control 173:104995. https://doi.org/10.1016/j.biocontrol.2022.104995

Mudede MF, Newete SW, Abutaleb K, Byrne MJ (2025) Monitoring a polyphagous shot hole borer infestation in an urban forest using Google street view in the City of Johannesburg, South Africa. Biological Invasions 27. https://doi.org/10.1007/s10530-025-03595-4

Muskett P, Sutton GF, Paterson (2024) Long-term post release evaluation shows *Hypogeococcus* sp. is an effective biological control agent for queen of the night cactus in South Africa. Biocontrol Science and Technology. 34:10, 915–920. https://doi.org/10.1080/09583157.2024.2391323

Nel WJ, Duong TA, Fell S, Herron DA, Paap T, Wingfield MJ, De Beer ZW, Hulcr J, Johnson AJ (2025) A checklist of South African bark and ambrosia beetles (Coleoptera: Curculionidae: Scolytinae, Platypodinae). Zootaxa 5648(1): 001–101. https://doi.org/10.11646/zootaxa.5648.1.1

Nelufule T, Robertson MP, Wilson JRU, Faulkner KT (2022) Native-alien populations—an apparent oxymoron that requires specific conservation attention. NeoBiota 74: 57–74. https://doi.org/10.3897/neobiota.74.81671

Nelufule T, Robertson MP, Wilson JRU, Faulkner KT (2023) An inventory of native-alien populations in South Africa. Scientific Data 10: 213. https://doi.org/10.1038/s41597-023-02119-w

Nelufule T, Shirindzi L, Shivambu T (in press) A comprehensive checklist of alien and invasive plant species within protected areas of the City of Johannesburg, Gauteng province, South Africa. African Biodiversity & Conservation.

Nelufule T, Shivambu TC, Shivambu N, Moshobane MC, Seoraj-Pillai N, Nangammbi T (2024) Assessing alien plant invasions in urban environments: a case study of Tshwane University of Technology and implications for biodiversity conservation. Plants 13: 872. https://doi.org/10.3390/plants13060872

Nelufule T, Shivambu TC, Spottiswoode KL, Spottiswoode SM, Shivambu N, Shirindzi L, Ngobeli B (in review) The role of citizen scientists in managing invasive alien plant species and aiding early detection in Kloofendal nature reserve, Johannesburg, South Africa. African Biodiversity & Conservation.

Nxele BJ (in review) Bridging Indigenous Knowledge Systems and Western ecological science approaches through language: the role of language in ecosystem restoration and invasive alien species management. African Biodiversity & Conservation.

O'Connor TG, van Wilgen BW (2020) The impact of invasive alien plants on rangelands in South Africa. In: van Wilgen BW, Measey J, Richardson DM, Wilson JRU, Zengeya TA (Eds.), Biological invasions in South Africa (pp. 459–485). Springer. https://doi.org/10.1007/978-3-030-32394-3_16

Paap T, De Beer ZW, Migliorini D, Nel WJ, Wingfield MJ (2018) The polyphagous shot hole borer (PSHB) and its fungal symbiont *Fusarium euwallaceae*: a new invasion in South Africa. Australian Plant Pathology 47: 231–237.

Pamla L, Vukeya LR, Mokotjomela TM (2024) The potential of foraging Chacma Baboons (*Papio ursinus*) to disperse seeds of alien and invasive plant species in the Amathole Forest in Hogsback in the Eastern Cape Province, South Africa. Diversity 16: 168. https://doi.org/10.3390/d16030168

Panetta FD, Dodd J (1987) The biology of Australian weeds. Journal of the Australian Institute of Agricultural Science 53(2): 83–95.

Paterson ID, Klein H, Muskett PC, Griffith TC, Mayonde S, Mofokeng K, Mnqeta Z, Venter N (2021) Biological control of Cactaceae in South Africa. African Entomology 29:713–734. https://hdl.handle.net/10520/EJC32918

Paterson ID, Motitsoe S, Coetzee JA, Hill MP (2024) Recent post-release evaluations of weed biocontrol programmes in South Africa: a summary of what has been achieved and what can be improved. BioControl. 69: 279–291. https://doi.org/10.1007/s10526-023-10215-4

Potgieter LJ, Cadotte MW, Kumschick S, Paap T, Roets F, Wilson JRU, Richardson DM (2025) An evidence-based protocol for developing lists for tree planting. NeoBiota 104: 113–137. https://doi.org/10.3897/neobiota.104.156206

Pretorius LM (2008) Introduced biological control agents of introduced insect pests to South Africa 1892 – 2008. Unpublished manuscript.

Rahlao SJ, Milton SJ, Esler KJ, Barnard P (2010) The distribution of invasive *Pennisetum setaceum* along roadsides in western South Africa: the role of corridor interchanges. Weed Research 50(6): 537–543. https://doi.org/10.1111/j.1365-3180.2010.00801.x

Rebelo AJ, Cogill L, Skosana T, Esler K (2025) Mapping woody invasive alien plant species and their impacts in strategic water source areas. Report No. 3193/1/24, Water Research Commission, Pretoria. https://www.wrc.org.za/wp-content/uploads/mdocs/3193%20final.pdf

Rebelo T (1993) Protea Atlas Project: a spectacular year of atlassing. Veld & Flora 79: 26–27.

Robertson MP, Cumming GS, Erasmus BFN (2010) Getting the most out of atlas data. Diversity and Distributions 16: 363–375. https://doi.org/10.1111/j.1472-4642.2010.00639.x

Robertson PA, Mill A, Novoa A, Jeschke JM, Essl F, Gallardo B, Geist J, Janic I, Lambin X, Musseau C, Pergl J, Pysek P, Rabitsch W, von Schmalensee M, Shirley M, Strayer DL, Stefansson RA, Smith K, Booy O (2020) A proposed unified framework to describe the management of biological invasions. Biological Invasions 22: 2633–2645. https://doi.org/10.1007/s10530-020-02298-2

Robinson TB, Peters K, Brooker B (2020) Coastal Invasions: the South African context. In: van Wilgen BW, Measey J, Richardson DM, Wilson JRU, Zengeya TA (Eds.), Biological invasions in South Africa (pp. 459–485). Springer. http://dx.doi.org/10.1007/978-3-030-32394-3_9

Rodríguez-Cala D, Fried J, Wilson JRU, Dehnen-Schmutz K, Tshwenyane SO, Legwaila I (2025a) Links between the ornamental sector and alien plants in Southern Africa. Geography and Environment 12: e70003. https://doi.org/10.1002/geo2.70003

Rodríguez-Cala D, Fried J, Wilson JRU, Dehnen-Schmutz K, Tshwenyane SO, Legwaila I (2025b) Ornamental horticulture in Southern Africa: strategic actions to address biological invasions. Environmental Management 75: 3203–3219. https://doi.org/10.1007/s00267-025-02241-y

Saccaggi DL, Arendse M, Wilson JRU, Terblanche JS (2021) Contaminant organisms recorded on plant product imports to South Africa 1994–2019. Scientific Data 8: 11. http://dx.doi.org/10.1038/s41597-021-00869-z

Sadchatheeswaran S, Branch GM, Moloney CL, Robinson TB (2018) Impacts of alien ecosystem engineers overwhelm inter-annual and seasonal shifts in rocky-shore community composition on Marcus Island, South Africa. African Journal of Marine Science 40: 137–147. https://doi.org/10.2989/1814232x.2018.1462729

Sadchatheeswaran S, Branch GM, Robinson TB (2015) Changes in habitat complexity resulting from sequential invasions of a rocky shore: implications for community structure. Biological Invasions 17: 1799–1816. https://doi.org/10.1007/s10530-014-0837-4

Schmeller DS, Julliard R, Bellingham PJ, Bohm M, Brummitt N, Chiarucci A, Couvet D, Elmendorf S, Forsyth DM, Moreno JG, Gregory RD, Magnusson WE, Martin LJ, McGeoch MA, Mihoub JB, Pereira HM, Proenca V, van Swaay CAM, Yahara T, Belnap J (2015) Towards a global terrestrial species monitoring program. Journal for Nature Conservation 25: 51–57. http://dx.doi.org/10.1016/j.jnc.2015.03.003

Scott LE, Skelton PH, Booth AJ, Verheust L, Harris R, Dooley J (2006) Atlas of southern African freshwater fishes. Smithiana Monograph 2. South African Institute for Aquatic Biodiversity, Makhanda.

Shepard JL, Beckett H, Gildenhuys CP, Potgieter LJ, Richardson DM (2025) *Ligustrum* L. (Oleaceae) in South Africa: introduction history and invasion ecology. South African Journal of Botany 182: 185–200. https://doi.org/10.1016/j.sajb.2025.05.001

Shivambu N, Shivambu TC, Downs CT (2022) Survey of non-native small mammals traded in South Africa. African Journal of Ecology 60: 456–466. https://doi.org/10.1111/aje.12999

Shivambu N, Shivambu TC, Nelufule T, Moshobane MC, Seoraj-Pillai N, Nangammbi TC (2024b) South Africa as a donor of its native and exotic species to the international pet trade. Sustainability 16: 8828. https://doi.org/10.3390/su16208828

Shivambu TC, Shivambu N, Nelufule T, Moshobane MC, Seoraj-Pillai N, Nangammbi TC (2024a) Evaluating the status of lost, found and sighted non-native pet bird species in South Africa. Diversity 16: 283. https://doi.org/10.3390/d16050283

Sifanele L, Shackleton M (2025) Homestead hedges as potential sources of alien invasive and poisonous plants in rural and urban communities, South Africa. Ecosystems and People 21(1): 2583992. https://doi.org/10.1080/26395916.2025.2583992

Skosana T, Esler KJ, Rebelo AJ (2025) Exploring the trade-offs between spatial and spectral resolution in mapping invasive alien trees. Available at SSRN 5226584. http://dx.doi.org/10.2139/ssrn.5226584

Steyn C, Robinson TB (2025) First record of the marine bryozoan *Membranipora membranacea* (Linnaeus, 1767) in South Africa. BioInvasions Records 14(2): 437–448. https://doi.org/10.3391/bir.2025.14.2.11

Steyn LAI, Jodamus Z, Steyn VM, Collop A, Addison MF, Bekker GFHvG, Esterhuizen N, Karsten M, Addison P (2025) First records of the fruit pest *Drosophila suzukii* (Matsumura, 1931) (Diptera: Drosophilidae) in South Africa. African Entomology 33: e22307. https://doi.org/10.17159/2254-8854/2025/a22307

Strydom T, Smit IPJ, Govender N, Coetsee C, Singh J, Davies AB, van Wilgen BW (2023) High-intensity fires may have limited medium-term effectiveness for reversing woody plant encroachment in an African savanna. Journal of Applied Ecology 60: 661–672. http://dx.doi.org/10.1111/1365-2664.14362

Symes CT, Ivanova IM, Howes CG, Martin RO (2021) Introduced and naturalized parrots of South Africa: colonization and the wildlife trade. In: Pruett-Jones S (Ed.) Naturalized parrots of the world: distribution, ecology, and impacts of the world's most colourful colonizers. Princeton University Press (New Jersey): 260–276.

Trembath J, Ntloko P, Kirkaldy AP, Mlambo MC (2023) First record of freshwater planarian *Girardia sinensis* Chen & Wang, 2015 (Platyhelminthes, Tricladida, Continenticola) in South Africa. BioInvasions Records 12(4): 1059–1068. https://doi.org/10.3391/bir.2023.12.4.18

van den Berg EC, Kotze I, Beukes H (2013) Detection, quantification and monitoring of *Prosopis* in the Northern Cape province of South Africa using remote sensing and GIS. South African Journal of Geomatics 2: 68–81. https://www.sajg.org.za/index.php/sajg/article/view/66

Van der Colff D, Kumschick S, Foden W, Wilson JRU (2020) Comparing the IUCN's EICAT and Red List to improve assessments of the impact of biological invasions. NeoBiota 62: 509–523. doi:10.3897/neobiota.62.52623

Van Deventer H, Smith-Adao l, Collins NB, Grenfell M, Grundling A, Grundling Pl, Impson D, Job N, Lotter M, Ollis D, Petersen C, Scherman P, Sieben E, Snaddon K, Tererai F, van der Colff D (2019) South African National Biodiversity Assessment 2018: Technical Report. Volume 2b: Inland Aquatic (Freshwater) Realm. South African National Biodiversity Institute (Pretoria): 1–408.

van Rooyen JA (2018) Systematic atlasing in Hessequa—Moving from mapping to monitoring. Biodiversity Observations 9(10): 1–13. https://doi.org/10.15641/bo.v9i0.508

van Rooyen JA, Underhill LG (2020) Systematic atlasing in Hessequa – Report on the first cycle of seasonal monitoring. Biodiversity Observations 11(3): 1–14. https://doi.org/10.15641/bo.933

van Wilgen B, Zengeya TA, Richardson D (2022a) A review of the impacts of invasive alien species in South Africa. Biological Invasions 24: 27–50. https://doi.org/10.1007/s10530-021-02623-3

van Wilgen BW, Baard J, Cheney C, Cole NS, Engelbrecht K, Stafford L, Turner AA, van Wilgen NJ, Wannenburgh A (2025) Progress towards the control of invasive alien species in the Cape Floristic Region's protected areas. Biological Invasions 27: 8. https://doi.org/10.1007/s10530-024-03459-3

van Wilgen BW, Reyers B, Le Maitre DC, Richardson DM, Schonegevel L (2008) A biome-scale assessment of the impact of invasive alien plants on ecosystem services in South Africa. Journal of Environmental Management, 89(4), 336–349. https://doi.org/10.1016/j.jenvman.2007.06.015

van Wilgen BW, Richardson DM (1985) The effects of alien shrub invasions on vegetation structure and fire behaviour in South African fynbos shrublands: a simulation study. Journal of Applied Ecology 22: 955–966. https://doi.org/10.2307/2403243

van Wilgen BW, Wannenburgh A, Wilson JRU (2022b) A review of two decades of government support for managing alien plant invasions in South Africa. Biological Conservation 274: 109741. https://doi.org/10.1016/j.biocon.2022.109741

van Wilgen NJ, Wright EJ, Baard J, Ahrends B, Cole N, Cheney C, Foxcroft LC, Spear D (2026) Streamlining alien species listing processes to enable prioritisation and reporting in protected areas: The case of alien plants in South African National Parks. NeoBiota 105: 177-208. https://doi.org/10.3897/neobiota.105.159101

Versfeld DB, Le Maitre DC, Chapman RA (1998) Alien invading plants and water resources in South Africa: A preliminary assessment. Water Research Commission, Pretoria.

Vezi MS, Downs CT, Zengeya TA (2024) Ornamental fish in the South African pet shop trade: potential risk to natural aquatic ecosystems. Biological Invasions 26: 3031–3047. https://doi.org/10.1007/s10530-024-03349-8

Vicente JR, Vaz AS, Roige M, Winter M, Lenzner B, Clarke DA, McGeoch MA (2022) Existing indicators do not adequately monitor progress toward meeting invasive alien species targets. Conservation Letters 15: e12918. https://doi.org/10.1111/conl.12918

Victorian Government (2010) Invasive plants and animals: Policy framework. Dept. of Primary Industries. https://agriculture.vic.gov.au/__data/assets/pdf_file/0009/582255/Invasive-Plants-and-Animals-Framework-Sep-22.pdf, accessed 1 July 2025.

Visser V, Wilson JRU, Canavan K, Canavan S, Fish L, Maitre DL, Nänni I, Mashau C, O'Connor TG, Ivey P, Kumschick S, Richardson DM (2017) Grasses as invasive plants in South Africa revisited: patterns, pathways and management. Bothalia: African Biodiversity and Conservation 47: a2169. https://doi.org/10.4102/abc.v47i2.2169

Vukeya LR, Mokotjomela TM, Pillay N (2025) Seed dispersal by vertebrates promotes invasion risk in the southern African grassland biome. Environmental Monitoring and Assessment 197: 1125. https://doi.org/10.1007/s10661-025-14569-3

Wickham H (2014) Tidy Data. Journal of Statistical Software 59: 1–23. https://doi.org/10.18637/jss.v059.i10

Wilkinson MD, Dumontier M, Aalbersberg IJ, Appleton G, Axton M, Baak A, Blomberg N, Boiten JW, Santos LBD, Bourne PE, Bouwman J, Brookes AJ, Clark T, Crosas M, Dillo I, Dumon O, Edmunds S, Evelo CT, Finkers R, Gonzalez-Beltran A, Gray AJG, Groth P, Goble C, Grethe JS, Heringa J, t Hoen PAC, Hooft R, Kuhn T, Kok R, Kok J, Lusher SJ, Martone ME, Mons A, Packer AL, Persson B, Rocca-Serra P, Roos M, van Schaik R, Sansone SA, Schultes E, Sengstag T, Slater T, Strawn G, Swertz MA, Thompson M, van der Lei J, van Mulligen E, Velterop J, Waagmeester A, Wittenburg P, Wolstencroft K, Zhao J, Mons B (2016) Comment: The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data 3: 9. https://doi.org/10.1038/sdata.2016.18

Williams VL, Burness A, Byrne MJ (2022) Medicinal plants sold by West, Central and East African immigrants in Johannesburg, South Africa. Transactions of the Royal Society of South Africa 77(1): 47–62. http://dx.doi.org/10.1080/0035919X.2021.2025167.

Williams VL, Burness A, Wojtasik EM, Byrne MJ (2021) Dataset, including a photo-guide, of alien plants sold in traditional medicine markets and healthcare outlets in three South African cities, specifically by traders of Indian, West African, East African, and Chinese origin. Data in Brief 38: 107395. https://doi.org/10.1016/j.dib.2021.107395

Wilson JR (2025) A list of taxa currently and historically regulated under South Africa's National Environmental Management: Biodiversity Act, Alien & Invasive Species Regulations. v1.1(20250325) https://doi.org/10.5281/zenodo.15082537

Wilson JR, Panetta FD, Lindgren C (2017) Detecting and responding to alien plant incursions. Cambridge University Press, 286 pp. https://doi.org/10.1017/CBO9781316155318

Wilson JRU, Bacher S, Daehler CC, Groom QJ, Kumschick S, Lockwood JL, Robinson TB, Zengeya TA, Richardson DM (2020a) Frameworks used in invasion science: progress and prospects. NeoBiota 62: 1–30. https://doi.org/10.3897/neobiota.62.58738

Wilson JRU, Datta A, Hirsch H, Keet J-H, Mbobo T, Nkuna KV, Nsikani MM, Pyšek P, Richardson DM, Zengeya TA, Kumschick S (2020b) Is invasion science moving towards agreed standards? The influence of selected frameworks. NeoBiota 62: 569–589. https://doi.org/10.3897/neobiota.62.53243

Wilson JRU, Dechoum MS, Faulkner KT, Langdon B, Pagad S, Pauchard A, Seebens H, Zengeya TA, Ziller SR (in review) Developing lists of alien taxa in the Global South. NeoBiota.

Wilson JRU, Faulkner KT, Fernández Winzer L, McCulloch-Jones EJ, et al. Zengeya TA (2025) A South African perspective on the 2023 IPBES Thematic Assessment Report on Invasive Alien Species and their control. African Biodiversity & Conservation, 55, 41 pages. https://doi.org/10.38201/abc.v55.9

Wilson JRU, Faulkner KT, Rahlao SJ, Richardson DM, Zengeya TA, van Wilgen BW (2018) Indicators for monitoring biological invasions at a national level. Journal of Applied Ecology 55: 2612–2620. https://doi.org/10.1111/1365-2664.13251

Wilson JRU, Ivey P, Manyama P, Nänni I (2013) A new national unit for invasive species detection, assessment and eradication planning. South African Journal of Science 109: (5/6) 13 Pages. https://doi.org/10.1590/sajs.2013/20120111

Wood AR (2017) Fungi and invasions in South Africa. Bothalia-African Biodiversity & Conservation 47(2): 1–16. https://doi.org/10.4102/abc.v47i2.2124

Wood AR, Den Breeyen A (2021) Plant pathogens and biological control of invasive alien plants in South Africa: a review of projects and progress (2011–2020). African Entomology 29:983–1004. https://doi.org/10.4001/003.029.0983

Woodford DJ, Impson ND, Day JA, Bills IR (2005) The predatory impact of invasive alien smallmouth bass *Micropterus dolomieu* (Teleostei: Centrarchidae) on indigenous fishes in a Cape Floristic Region Mountain stream. African Journal of Aquatic Science 30(2) 167–173. https://doi.org/10.2989/16085910509503852

Zachariades C (2021) A catalogue of natural enemies of invasive alien plants in South Africa: classical biological control agents considered, released and established, exotic natural enemies present in the field, and bioherbicides. African Entomology 29(3):1077–1142. https://doi.org/10.4001/003.029.1077

Zengeya TA, Faulkner KT, Mtileni MP, Fernandez Winzer L, Kumschick S, McCulloch-Jones EJ, Miza-Tshangana SA, Robinson TB, Sifuba A, Engelbrecht W, van Wilgen BW, Wilson JRU (in press) A list of alien taxa for South Africa. African Biodiversity & Conservation: [preprint at https://www.biorxiv.org/content/10.1101/2025.05.22.655507]

Zengeya TA, Faulkner KT, Mtileni MP, Wilson JRU (2025) Lessons and challenges in creating alien species lists: insights from South Africa's national reports on the status and management of biological invasions. Neobiota 101: 203-222. https://doi.org/10.3897/neobiota.101.162932

Zengeya TA, Wilson JR (eds.) (2023) The status of biological invasions and their management in South Africa in 2022. South African National Biodiversity Institute, Kirstenbosch and DSI-NRF Centre of Excellence for Invasion Biology, Stellenbosch. http://dx.doi.org/10.5281/zenodo.8217182

Zenni RD, Wilson JRU, Le Roux JJ, Richardson DM (2009) Evaluating the invasiveness of *Acacia paradoxa* in South Africa. South African Journal of Botany 75: 485–496. https://doi.org/10.1016/j.sajb.2009.04.001

Links to appendices and supplementary material

Copies of the files will be permanently available at the links below. For files that will be periodically updated (e.g., the list of alien taxa) the doi link will resolve to the latest copy of the file, but other versions will be visible at that link. If the reader wishes to get the specific copy of the document that was linked to this report, please navigate to the appropriate version.

Item	Web-link	QR code
The status of biological invasions and their management in South Africa in 2025 [DRAFT FOR PUBLIC COMMENT]	http://dx.doi.org/10.5281/zenodo.17697657	
Supplementary Material	http://dx.doi.org/10.5281/zenodo.18314515	
Appendix 1: Indicator factsheets	http://dx.doi.org/10.5281/zenodo.17739011	
Appendix 2: Workflows [Note: as several workflows are still under development, updated versions of all workflows are not included here, the link points to the workflows of SANBI and CIB (2023)]	https://doi.org/10.5281/zenodo.7433129	
Appendix 3: List of data sources	https://doi.org/10.5281/zenodo.17739442	
Appendix 4: Species level pathway data	https://doi.org/10.5281/zenodo.3582021	

Item	Web-link	QR code
Appendix 5: Pathways change tracker	https://doi.org/10.5281/zenodo.3947798	
Appendix 6: The list of alien taxa	https://doi.org/10.5281/zenodo.7433102	
Appendix 7: References used in the list of alien taxa	https://doi.org/10.5281/zenodo.17185375	
Appendix 8: Metadata for the list of alien taxa	https://doi.org/10.5281/zenodo.7433112	
Appendix 9: Permits issued under the NEM:BA A&IS Regulations 2014–2022 [Note: to be updated to 2023–2025]	https://doi.org/10.5281/zenodo.3947809	

QR code that resolves to the latest available version of the status report (http://dx.doi.org/10.5281/zenodo.7414803)